



MACHAKOS UNIVERSITY

University Examinations 2022/2023

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR FIRST SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE (APPLIED PHYSICS AND TECHNOLOGY)

SPH 309: MATERIAL PHYSICS

DATE:

TIME:

INSTRUCTIONS:

Answer **Question ONE** which is compulsory and any other **TWO**

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

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|-----|--|---------------------|-----------|
| (a) | Describe the following | (i) Covalent forces | (3 marks) |
| | | (ii) Ionic forces | (3 marks) |
| (b) | What is meant by reinforced polymers | | (2 marks) |
| (c) | Explain three disadvantages of centre-loading of beams | | (3 marks) |
| (d) | Distinguish uniform and steady flow | | (3 marks) |
| (e) | Derive an expression for the bulk modulus of a body | | (4 marks) |
| (f) | In conducting test on materials, explain why it is more appropriate to analyse stress-strain relations than those of force-extension | | (2 marks) |
| (g) | Explain the effects of mechanical stress on corrosion | | (3 marks) |
| (h) | (i) What is meant by a composite material | | (2 marks) |
| | (ii) State three weaknesses of composites | | (3 marks) |
| (i) | Distinguish between rusting and corrosion | | (2 marks) |

SECTION B (ATTEMPT ANY TWO)

QUESTION TWO (20 MARKS)

- (a) On parallel grids for comparison, sketch the following relationships due to the interaction between the particles in a body
- (i) Force - distance (4 marks)
 - (ii) Potential energy-distance (4 marks)
- (b) The energy of dissociation of a lattice is given by $U(r) = -\frac{a}{r^m} + \frac{b}{r^n}$
- (i) Explain each term in the equation, indicating the relationship between m and n (4 marks)
 - (ii) Find an expression for the equilibrium distance in terms of a , b , m and n (4 marks)
 - (iii) Show that the minimum energy is given by $U_{min} = -\frac{a}{r^m} \left(1 - \frac{m}{n}\right)$ (4 marks)

Question Three (20 MARKS)

- (a) For a viscous undergoing laminar flow, show that the rate of shear strain is equal to the velocity gradient (4 marks)
- (b) (i) Define a Newtonian liquid (2 marks)
- (ii) Show that the coefficient of viscosity of a Newtonian liquid depends on the rate of change of the strain in the liquid (4 marks)
- (b) (i) Distinguish between critical and terminal velocity (2 marks)
- (ii) Using the forces acting on a body moving in a long column of a viscous fluid, show that its terminal velocity is constant (8 marks)

QUESTION FOUR (20 MARKS)

- (a) (i) Explain why materials under tension are more likely to fracture along planes of 45° to the direction of the shearing force (4 marks)
- (ii) For small angles of shear, show that the shear modulus, G is inversely proportional to the angle of shear (4 marks)
- (b) Describe each of the four basic components of concrete (12 marks)

QUESTION FIVE (20 MARKS)

- (a) Distinguish between (i) alloying and galvanizing (2 marks)
- (ii) eutectic and eutectoid mixtures (2 marks)

- (b) Explain two methods of alloying (6 marks)
- (c) Explain three advantages of alloying (6 marks)
- (d) From a phase diagram, show how the weight of a solid can be obtained from the liquid and solid curves (4 marks)