



# STAMFORD COLLEGE SCHOOL OF ENGINEERING

FOUNDATION STUDIES IN ENGINEERING

KE 010: MATTER & MATERIAL SCIENCE

**Date : October 2007**

**Time: 9.30 am – 11.40 am**

**Duration: 2 hours + 10 minutes reading time**

## **Instructions to Candidates:**

- Instructions:
1. SIX questions set.
  2. Answer Any FOUR questions.
  3. All questions carry equal marks.
  4. Maximum marks attainable: 100

Please ensure that this examination paper contains SIX questions on TWO printed pages before you start the examination.

Books, papers or any other written materials are not allowed to be brought into the examination hall. A candidate who violates the examination rules of Stamford College or commits a malpractice will be disqualified from the examination.

Write your Examination Index Number on each page of your answer booklet.

**ANSWER ANY FOUR QUESTIONS****Question 1**

- a) A sample initially consists of  $N_0$  radioactive atoms of an isotope. After a time  $t$ , the number  $N$  of radioactive atoms of the isotope is given by

$$N = N_0 e^{-\lambda t}$$

where  $\lambda$  is the decay constant.

- i) Sketch a graph of this equation and show on the graph the time equal to the half-life of the sample,  $t_{1/2}$ . (5 marks)
- ii) Using the above equation, derive the expression for the rate of disintegration for the sample. (5 marks)
- b) A sample of a radioactive material contains  $10^{18}$  atoms. The half-life of the material is 2000 days. Calculate :
- i) the fraction remaining after 500 days, (7 marks)
- ii) the activity of the sample after 500 days. (8 marks)
- (Total: 25 marks)

**Question 2**

- a) Explain, using suitable examples, what is meant by:
- i) ionic bonding, (5 marks)
- ii) covalent bonding, (5 marks)
- iii) metallic bonding. (6 marks)
- b) What are the consequences of this type of bonding for:
- i) melting point? (3 marks)
- ii) hardness? (3 marks)
- iii) electrical conductivity? (3 marks)
- (Total: 25 marks)

**Question 3**

- a) Define tensile stress, tensile strain and Young's modulus. What are the units and dimensions of each? (15 marks)
- b) A steel rod, 25 mm diameter and 6 m long, extends 6 mm under a pull of 100kN. Calculate the stress and strain in the rod. (10 marks)
- (Total: 25 marks)

**Question 4**

- a) How many atoms per cube unit cell are there in:
- i) a body-centred structure? (2 marks)
  - ii) a face-centred structure? (2 marks)
- Calculate the packing factor for a face-centred cubic lattice. (5 marks)
- b) Given a face-centred cubic unit cell with a lattice constant  $a = 4.0 \times 10^{-10}$  m, compute the number of atoms per unit area on (110) and (111) planes and the density of atoms per unit length in directions [110] and [111]. (16 marks)
- (Total: 25 marks)

**Question 5**

- a) Describe the 4 quantum numbers of an electron and give their allowed values. (16 marks)
- b) Show that in the L – shell when  $n = 2$ , the total number of states available is 8. (9 marks)
- (Total: 25 marks)

**Question 6**

- a) Describe 2 methods by which cathodic protection can be used to protect a steel pipe from corroding. (12 marks)
- b) Describe some of the techniques used to reduce or prevent corrosion. (13 marks)
- (Total: 25 marks)

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