

Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
300 level 2nd Semester Examination – Dec./Jan. 2017
SCT 343-2 Functional Properties of Materials



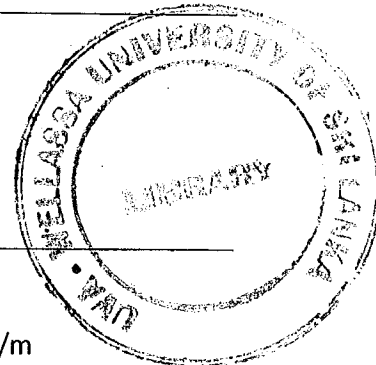
Instructions to candidates

Duration: 02 hours

Number of questions: 04

Answer **all** questions

Mark allocation: 120 marks



Charge of an electron = 1.6×10^{-19} C

Avogadro's number $N_A = 6.023 \times 10^{23}$

Electric permittivity of a vacuum $\epsilon_0 = 8.85 \times 10^{-12}$ F/m

Universal gas constant $R = 8.31$ J/mol.K

Magnetic permeability of a vacuum $\mu_0 = 1.257 \times 10^{-6}$ H/m

Bohr magneton $\mu_B = 9.27 \times 10^{-24}$ A/m²

1.
 - a. Briefly explain the following terms related to semiconductor materials.
Intrinsic , Extrinsic , n-type, p-type
(08 marks)
 - b. What are the two major functions of a transistor in an electrical circuit ?
(04 marks)
 - c. Briefly explain why the ferroelectric behavior of BaTiO₃ ceases above its ferroelectric Curie temperature.
(06 marks)
 - d. At room temperature, the electrical conductivity of a material is $25 (\Omega\text{m})^{-1}$, whereas the electron and hole mobilities are $0.06 \text{ m}^2/\text{V.s}$ and $0.02 \text{ m}^2/\text{V.s}$, respectively. Compute the intrinsic carrier concentration for this material at room temperature.
(12 marks)
2.
 - a. Briefly describe the phenomenon of magnetic hysteresis and why it occurs for ferromagnetic and ferri magnetic materials.
(06 marks)
 - b. Briefly explain the Meissner effect.
(06 marks)

c. Write down the differences between type I and type II superconductors in point form.

(06 marks)

d. Assume that a metal exhibits ferromagnetic behavior and has a simple cubic crystal structure as shown in Figure 01 below. It has an atomic radius of 0.125 nm, and a saturation flux density of 0.85 tesla. Determine the number of Bohr magnetons per atom for this material.

(12 marks)

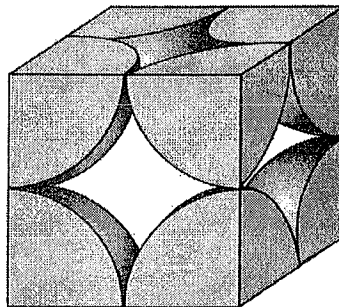


Figure 01

3.

a. Explain the difference between the materials that are opaque, translucent, and transparent in terms of their appearance and light transmittance.

(08 marks)

b. What is the difference between fluorescence and phosphorescence?

(04 marks)

c. Briefly explain what determines the characteristic color of (a) a metal and (b) a transparent nonmetal.

(06 marks)

d. The fraction of non-reflected radiation that is transmitted through a 5 mm thickness of a transparent material is 0.95. If the thickness is increased to 12 mm, what fraction of light is transmitted?

(12 marks)

4.

a. Briefly explain thermal expansion using the potential energy versus interatomic spacing curve.

(06 marks)

b. Briefly describe why porosity decreases the thermal conductivity of ceramic and polymeric materials.

(06 marks)

c. Briefly explain how the degree of crystallinity affects the thermal conductivity of polymeric materials and justify your answer.

(06 marks)

d. Railroad tracks made out of steel are to be laid during the time of year when the temperature averages 24 °C. If a joint space of 3.0 mm is allowed between standard rails of length 12.0 m, what is the highest possible temperature that can be tolerated without the introduction of thermal stresses? Note that the linear coefficient of thermal expansion for steel is $16 \times 10^{-6} \text{ }^\circ\text{C}^{-1}$.

(12 marks)

