UNIVERSITI SAINS MALAYSIA

KSCP Semester Examination
Academic Session 2004/2005

May 2005

ZCT 307E/3 - Solid State Physics I
[Fizik Keadaan Pepejal I]

Duration 3 hours
[Masa 3 jam]

Please check that the examination paper consists of **THREE** pages of printed material before you begin the examination

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **TIGA** muka surat yang bercetak sebelum anda memulakan peperiksaan ini]*

Instruction Answer all **SIX** questions Students are allowed to answer all questions in Bahasa Malaysia or in English

*[**Arahan** Jawab kesemua **ENAM** soalan Pelajar dibenarkan menjawab semua soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris]*

1 Plot an experimental graph of specific heat C_v versus temperature (Show all the physical parameters on the graph) of a typical solid Explain the failure of the classical law on the basis of Debye's model
[Surihkan graf eksperimen haba spesifik C_v lawan suhu bagi pepejal tipikal Jelaskan kegagalan hukum klasik berdasarkan model Debye]

(15/100)

2 The specific heat of diamond at 20 °K is 2 45 joule $kmol^{-1}kelvin^{-1}$ Calculate the highest lattice frequency involed in the Debye theory
[Haba tentu berlian pada 20°K adalah 2 45 joule $kmol^{-1}$ $kelvin^{-1}$ Hitung frekuensi kekisi tertinggi dalam theory Debye]

(10/100)

3 Discuss how Sommerfeld quantum theory of free electrons explain the failure of the classical theory pertaining to the specific heat of solid
[Bincangkan bagaimana theory kuantum Sommerfeld menjelaskan kegagalan teori klasik berkaitan haba tentu pepejal]

(15/100)

4 State the nature of the Fermi distribution function (plot the required graph) How does it varies with temperature?
[Nyatakan sifat fungsi taburan Fermi (surihkan graph yang bersesuaian) Bagaimanakah ianya berubah terhadap suhu?]

(10/100)

5 (a) The equation below is derived from the Kronig-Penney Model for an electron in a periodic field
[Dari model Kronig-Penney persamaan berikut telah diterbitkan]

$$P\frac{\sin \alpha a}{\alpha a} + \cos \alpha a = \cos ka$$

where *[di mana]* $P = \frac{mV_o ba}{\hbar^2}$ and *[dan]* $\alpha^2 = \frac{2mE}{\hbar^2}$

(i) Explain the physical meaning of all the terms in the equation above
[Jelaskan maksud fizikal bagi semua sebutan persamaan di atas]

(ii) Plot a graph of $P\frac{\sin \alpha a}{\alpha a}+\cos \alpha a$ versus αa Discuss what you can deduce from the graph
[Plot graf $P\frac{\sin \alpha a}{\alpha a}+\cos \alpha a$ *lawan* αa *Bincang apa yang anda perolehi dari graf tersebut]*

(b) Show from the E-k graph that materials can be classified into conductors, insulators and semiconductors
[Dari graf E-k bagaimanakah anda boleh mengkelaskan bahan konduktor, penebat dan semikonduktor]

(30/100)

6 (a) Show that for the case of intrinsic semiconductors, the carrier concentration is given by
[Tunjukkan bagi kes semikonduktor intrinsik, kepekatan pembawa diberi oleh]

$$n = p = n_i = 2(\frac{k_B T}{2\pi\hbar^2})^{3/2}(m_e m_h)^{3/4} e^{-E_g/2k_B T}$$

(b) The gap for an intrinsic semicondutor is E_g = 0 7 eV at room temperature (300 K) Determine the position of the Fermi level at 300 K Also calculate the density of holes and electrons at 300 K Given $m_p^* = 6m_e^*$
[Jurang tenaga bagi sesuatu semikonduktor intrinsik adalah E_g *= 0 7 eV pada suhu bilik (300 K) Tentukan kedudukan paras Fermi pada 300 K Juga hitung ketumpatan lohong dan elektron pada 300 K*
Diberi $m_p^* = 6\, m_e^*$*]*

(20/100)