UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2007/2008

October/November 2007

EBB 202/3 - Crystallography & Bonding In Solids
[Kristalografi & Ikatan Dalam Pepejal]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains EIGHT printed pages and TWO pages APPENDIX before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi LAPAN muka surat beserta DUA muka surat LAMPIRAN yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper contains SEVEN questions. ONE question in PART A, THREE questions in PART B and THREE questions in PART C.
[Kertas soalan ini mengandungi TUJUH soalan. SATU soalan di BAHAGIAN A, TIGA soalan di BAHAGIAN B dan TIGA soalan di BAHAGIAN C.]

Instructions: Answer **FIVE** questions. Please answer **ALL** questions in PART A, **TWO** questions in PART B and **TWO** questions from PART C. If a candidate answers more than five questions, only the first five answers will be examined and awarded marks.
*[**Arahan:** Jawab **LIMA** soalan. Jawab **SEMUA** soalan di BAHAGIAN A, **DUA** soalan di BAHAGIAN B dan **DUA** soalan di BAHAGIAN C. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

Answer to any question must start on a new page.
[Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

PART A

BAHAGIAN A

1. [a] How does the symmetry of crystals (space and point group symmetry) useful in the study of crystalline materials? Explain with appropriate examples.

Bagaimanakah simetri hablur (kumpulan simetri titik dan ruang) berguna dalam kajian bahan-bahan hablur? Jelaskan dengan beberapa contoh berkaitan.

(30 marks/*markah*)

[b] Define the following terms: symmetry of crystals, symmetry elements and symmetry operation.

Definasikan terma-terma yang berikut: simetri hablur, elemen-elemen simetri dan operasi simetri.

(20 marks/*markah*)

[c] (i) Draw all three dimensional Bravais lattices for cubic.

Lukiskan semua kekisi Bravais tiga dimensi bagi kiub.

(15 marks/*markah*)

(ii) Draw all three dimensional Bravais lattices for Tetragonal.

Lukiskan semua kekisi Bravais tiga dimensi bagi tetragonal.

(10 marks/*markah*)

(iii) A sample of BCC iron was placed in an X-ray diffractometer using incoming X-rays with a wavelength λ = 0.1541 nm. Diffraction from the {110} planes was obtained at 2θ = 44.704°. Calculate a value for the lattice constant of BCC iron. (Assume first order diffraction with n = 1)

Satu sampel besi KBJ telah diletakkan dalam meterpembelau sinar-X menggunakan sinar-X tuju yang panjang gelombang λ = 0.1541 nm. Pembelauan dari satah-satah {110} didapati pada 2θ = 44.704°. Kirakan nilai untuk pemalar kekisi bagi besi KBJ. (Anggapkan tertib pertama dengan n = 1)

(25 marks/*markah*)

PART B

BAHAGIAN B

2. [a] Appendix 1 and 2 gives 4 crystals. Identify the symmetry elements that each of the crystals have and suggest the point group symmetry that these crystal might belong to. Please draw on the paper and attach with your answer book.

Lampiran 1 dan 2 memberikan 4 hablur. Kenalpasti elemen-elemen simetri yang dipunyai oleh setiap satu hablur tersebut dan cadangkan dalam kumpulan simetri titik manakah hablur-hablur ini tergolong. Sila lukis di atas kertas tersebut dan hantar bersama buku jawapan.

(60 marks/*markah*)

[b] Explain, with appropriate drawings, about the translational symmetry elements and how are they different from the basic symmetry elements?

Terangkan, dengan lakaran yang sesuai, mengenai elemen-elemen simetri peralihan dan bagaimanakah elemen-elemen ini berbeza daripada elemen-elemen simetri asas?

(40 marks/*markah*)

3. [a] Discuss briefly about the following topics:

(i) Atomic models and the importance of this study.

(ii) Stereographic projections and their importance.

(iii) Amorphous, crystallinity and polymorphism – why do we need to know these states of materials?

Bincangkan secara ringkas mengenai tajuk-tajuk berikut:

(i) Model-model atom dan kepentingan kajian ini.

(ii) Unjuran stereografik dan kepentingannya.

(iii) Amorfus, kehabluran dan polimorfus – mengapakah kita perlu mengetahui keadaan-keadaan tersebut bagi bahan?

(50 marks/*markah*)

[b] Explain how ductility, modulus of Elasticity, hardness and strength is influenced by the type of bonding and the crystal structure? Why do certain metals are more ductile compared to the others?

Terangkan bagaimana kemuluran, modulus keelastikan, kekerasan dan kekuatan dipengaruhi oleh jenis ikatan dan struktur hablur? Mengapakah sesetengah logam lebih mulur berbanding yang lain?

(50 marks/*markah*)

4. [a] With appropriate drawing, explain about the development of point group symmetry.

Dengan lakaran yang sesuai, terangkan mengenai pembangunan kumpulan simetri titik.

(50 marks/*markah*)

[b] Draw the stereographic projection of following point group symmetry:

(i) 3 2 2

(ii) 4bar 2 m

(iii) 3bar 2/m

(iv) 6/m 2/m 2/m

(v) 4 m m

Lukis unjuran stereografik kumpulan simetri titik yang berikut:

(i) 3 2 2

(ii) 4bar 2 m

(iii) 3bar 2/m

(iv) 6/m 2/m 2/m

(v) 4 m m

(50 marks/*markah*)

PART C

BAHAGIAN C

5. [a] Define what is filter in X-ray machine?

Apakah definisi bagi penapis dalam mesin sinar-X?

(10 marks/*markah*)

[b] What are the materials can be used as filter and it target?

Bahan-bahan apakah yang boleh digunakan sebagai penapis dan sasarannya?

(20 marks/*markah*)

[c] For the X-ray machine using Cu, Mn and Fe as filter, briefly explain with the appropriate graph plot how its works?

Bagi mesin sinar-X yang menggunakan Cu, Mn dan Fe sebagai penapis, terangkan dengan lakaran graf bagaimana ia berfungi?

(70 marks/*markah*)

6. [a] Briefly explain, what is the different the X-ray diffraction in measurement between flat plate and powder sample?

Terangkan secara ringkas apakah perbezaan dalam pengukuran pembelauan sinar-X sampel kepingan rata dan serbuk?

(20 marks/*markah*)

[b] Which of the following indices are allowed for in the FCC structure pattern of AgCl; 100, 010, 001, 200, 020, 002, 110, 101, 011, 120, 102, 012, 210, 201, 021, 220, 202, 022, 111, 222, 221, 212, 122, 211, 121, 112?

Di antara indek-indek berikut, yang manakah dibenarkan dalam stuktur KBM bagi corak AgCl; 100, 010, 001, 200, 020, 002, 110, 101, 011, 120, 102, 012, 210, 201, 021, 220, 202, 022, 111, 222, 221, 212, 122, 211, 121, 112?

(20 marks/*markah*)

[c] (i) Calculate the distance between two Polonium (P_O) atoms that lie along a body diagonal, given a = 0.336 nm.

Kirakan jarak antara dua atom Polonium (P_O) yang terletak sepanjang badan diagonal, diberi a = 0.336 nm.

(30 marks/*markah*)

(iii) Calculate the distance between the body-centered atoms and one corner atom in Na, given a = 0.424 nm.

Kirakan jarak antara dua atom di antara berpusat jasad dan atom di sudut dalam Na, diberi a = 0.424 nm.

(30 marks/*markah*)

7. [a] Prove and explain the structure factor in base-centered cell structure.

Buktikan dan terangkan faktor struktur dalam struktur sel berpusat.

(50 marks/*markah*)

[b] Determine the structure factor for the 111 and 200 planes in NaCl assuming Na^+ ions at (000), (½½0), (½0½), and (0½½) and Cl^- ions at (0½0), (½00), (00½), and (½½½). Assume that $f_+ = 9.2$ and $f_- = 14.4$ for the 111 plane and $f_+ = 7.4$ and $f_- = 10.0$ for the 220 plane.

Tentukan faktor struktur untuk satah-satah 111 dan 200 dalam NaCl dengan menggangap ion Na pada (000), (½½0), (½0½), dan (0½½) dan ion Cl pada (0½0), (½00), (00½) dan (½½½). Anggapkan f 9.2 dan f 14.4 untuk satah 111 dan f 7.4 and f =10.0 untuk satah 220.

(50 marks/*markah*)

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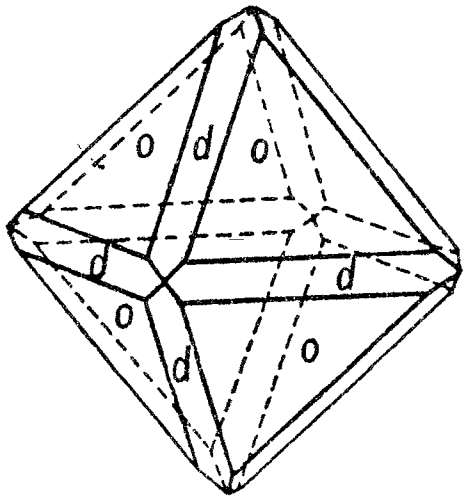
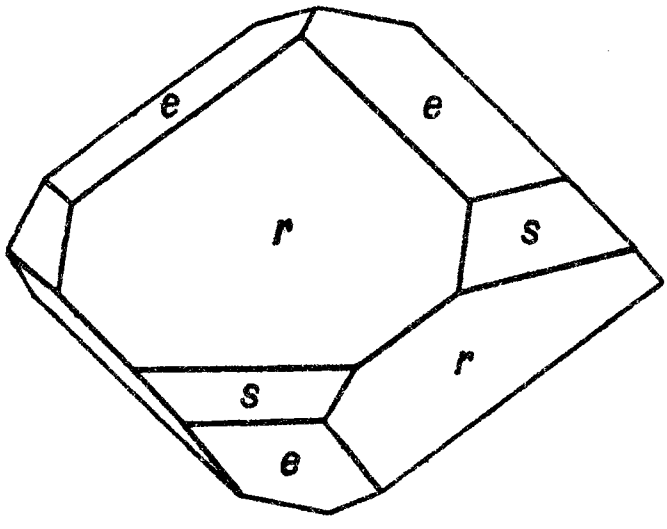
APPENDIX 1

LAMPIRAN 1



(i) Spinel crystals / *Hablur spinel*



(ii) Chabazite