
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2011/2012

January 2012

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

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains TWELVE printed pages before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi DUA BELAS muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper consists of 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.]

Instruction: Answer FIVE questions. Answer ALL question from PART A, TWO questions from PART B and TWO questions from PART C. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.

[Arahan: Jawab LIMA soalan. Jawab SEMUA soalan dari BAHAGIAN A, DUA soalan dari BAHAGIAN B dan DUA soalan dari BAHAGIAN C. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]

The answers to all questions must start on a new page.

[Mulakan jawapan anda untuk semua 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.]

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

PART A / BAHAGIAN A

1. [a] Describe factors influencing the formation of a metallic Bond.

Jelaskan faktor-faktor yang mempengaruhi pembentukan ikatan logam.

(20 marks/markah)

- [b] The formation of metallic bond in metals such as a copper allows them to conduct the electric current and ductile properties. How could you correlate these properties with the existence of metallic bond.

Wujudnya ikatan logam dalam logam-logam seperti tembaga membolehkannya mengalir arus elektrik dan bersifat boleh lentur. Bagaimana sifat-sifat tersebut boleh dikaitkan dengan kehadiran ikatan logam.

(30 marks/markah)

- [c] (i) What is the difference between X-ray diffraction (XRD) and X-ray fluorescence (XRF) quantitative analysis?

Apakah perbezaan di antara pembelauan sinar-X (XRD) dan X-ray pendarfluor (XRF) analisis kuantitatif?

(10 marks/markah)

- (ii) What are the limitations of XRD quantitative analysis?

Apakah kelemahan analisis kuantitatif XRD?

(10 marks/markah)

- (iii) What is crystallinity in XRD quantitative analysis?

Apakah maksud penghabluran dalam analisis kuantitatif XRD?

(10 marks/markah)

- (iii) Determine the indices for the plane shown in the hexagonal unit cells, in Figure 1.

Tentukan indeks bagi satah yang ditunjukkan dalam sel unit heksagon bagi Rajah 1.

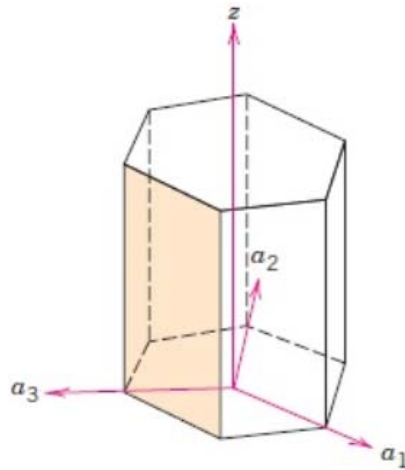


Figure 1 - Hexagonal unit cell

Rajah 1 - Sel unit heksagon

(20 marks/markah)

PART B / BAHAGIAN B

2. [a] Which experiment that Rutherford was forced to discard the Thomson's raisin bread model (plum pudding model) which cannot be valid as an atomic model. What was a new atomic model proposed by Rutherford?

Eksperimen yang manakah memaksa Rutherford menolak cadangan model atom roti berkismis atau model puding bermemplam Thomson. Apakah model atom cadangan Rutherford yang baru?

(30 marks/markah)

- [b] Describe the following:

- (i) the concept of symmetry element and symmetry operation.
- (ii) the concept of point group and space group of a crystal.

Jelaskan yang berikut:

- (i) *Konsep unsur simetri dan operasi simetri*
- (ii) *Konsep kumpulan ruang dan kumpulan titik bagi suatu hablur.*

(30 marks/markah)

- [c] Give a point groups and characteristic symmetry elements of the following crystal systems:

- (i) Cubic
- (ii) Tetragonal
- (iii) Trigonal
- (iv) Monoclinic

Berikan kumpulan titik dan ciri unsur simetri bagi sistem hablur berikut:

- (i) *Kubus*
- (ii) *Tetragonal*
- (iii) *Trigonal*
- (iv) *Monoklinik*

(40 marks/markah)

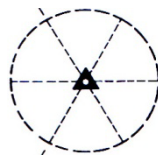
3. [a] What point group is developed through interaction of two 2- fold axes at 90° to each other? (b) at 60° ? (c) at 30° ? (d) at 45° ?

Apakah kumpulan titik yang terbentuk melalui interaksi antara dua 2-pusat paksi pada sudut 90° antaranya? (b) pada 60° ? (c) pada 30° ? (d) pada 45° ?

(40 marks/markah)

- [b] Draw the symmetry elements and names point group using Hermann-Mauguin(HM) symbol for the following stereograms (Figure 2):

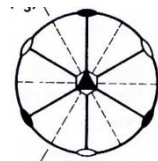
Lakarkan unsur-unsur simetri dan namakan kumpulan titik (HM) bagi setiap stereogram berikut (Rajah 2):



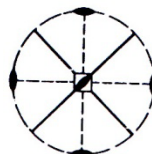
(a)



(b)



(c)



(d)

Figure 2 / Rajah 2

(60 marks/markah)

4. [a] Defines:
- (i) Glide plane or glide reflection
 - (ii) Screw axes or screw rotation

Takrifkan:

- (i) *Bidang geluncur atau balikan geluncur*
- (ii) *Paksi skru atau putaran skru*

(30 marks/markah)

- [b] Using the Einstein formula

$$E = mc^2$$

Prove that momentum of photon, $p = h/\lambda$

Where E , m , c is usual symbols h is plank constant and λ is wavelength.

Bermula dengan formula Einstein

$$E = mc^2$$

Buktikan yang momentum photon $p = h/\lambda$

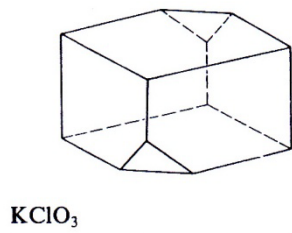
Dengan mengambil E , m , c adalah simbol-simbol lazim dan h adalah pemalar plank dan λ adalah panjang gelombang.

(40 marks/markah)

- [c] Identify all the symmetry elements possessed by each of the crystals given in Figure 3. Suggest the point group symmetry that each crystal belongs to.

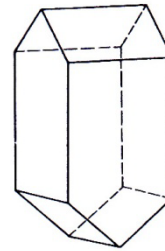
Kenalpastikan semua elemen simetri yang terdapat pada setiap hablur yang diberikan dalam Rajah 3. Cadangkan kumpulan titik simetri yang mana setiap hablur tersebut tergolong.

(30 marks/markah)



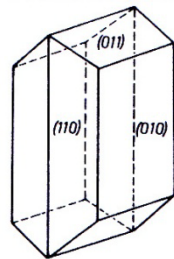
KClO₃

(a)



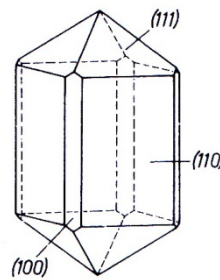
MgSO₄ · 7H₂O (Epsomite)

(b)



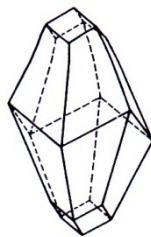
CaCO₃ (Aragonite)

(c)



TiO₂ (Rutile)

(d)



CaCO₃ (Calcite)

(e)

Figure 3 / Rajah 3

PART C / BAHAGIAN C

5. [a] Figure 4 shows spectrum of molybdenum as a function of applied voltage (not to scale), identify where this reaction occurs?

Rajah 4 menunjukkan spektrum molibdenum sebagai fungsi voltan yang dikenakan (tidak mengikut skala), tentukan di mana tindakbalas ini berlaku?

(10 marks/markah)

- [b] Explain Figure 4 in detail.

Terangkan secara terperinci mengenai Rajah 4.

(20 marks/markah)

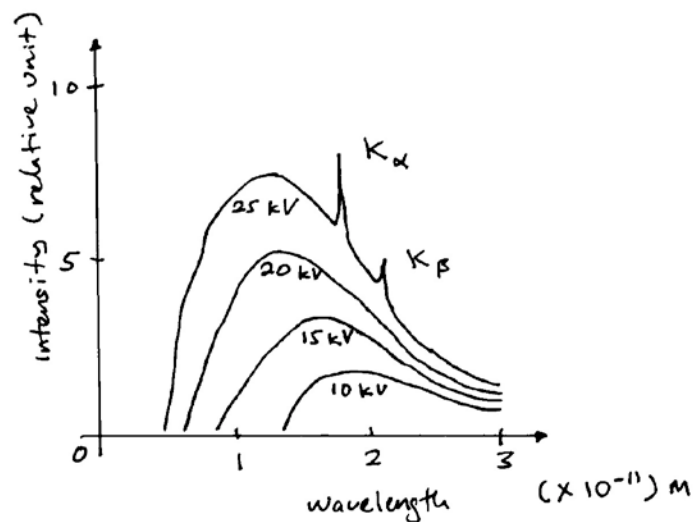


Figure 4 - Spectrum of molybdenum

Rajah 4 - Spektrum molibdenum

- [c] If you are given a chromium (Cr) target by applying an acceleration potential (V) of 60 kV and $Z_{Cr} = 24$, $R = 1.097 \times 10^7 \text{ m}^{-1}$.

Jika anda diberikan kromium (Cr) sasaran dengan menggunakan kemampuan pecutan (V) sebanyak 60 kV dan $Z_{Cr} = 24$, $R = 1.097 \times 10^7 \text{ m}^{-1}$.

- (i) Calculate λ_{swl} and λ_{α} .

Kira λ_{swl} dan λ_{α} .

(20 marks/markah)

- (ii) Referring to 5 [c] (i), draw and label a schematic of the x-ray spectrum emitted by this target.

Dengan merujuk kepada jawapan 5 [c] (i), lakarkan dan label skema spektrum sinar-x yang dipancarkan oleh sasaran ini.

(30 marks/markah)

- (iii) Referring to 5 [c] (ii), label λ_{swl} , λ_{β} and λ_{α} .

Dengan merujuk kepada jawapan 5 [c] (ii), labelkan λ_{swl} , λ_{β} dan λ_{α} .

(20 marks/markah)

6. [a] Prove Braggs Law by using appropriate drawings, concept and trigonometry.

Buktikan Hukum Braggs dengan menggunakan lakaran, konsep dan trigonometri yang sesuai.

(60 marks/markah)

- [b] In Braggs Law equation, n must be integer numbers ($n = 1, 2, 3, 4 \dots$). Using appropriate drawings, differentiate n with integer number and not integer (fraction) numbers.

Dalam persamaan Hukum Braggs, n mesti nombor integer ($n = 1, 2, 3, 4 \dots$). Dengan menggunakan lukisan sesuai, bezakan n menggunakan nombor integer dan tidak nombor (pecahan) integer.

(40 marks/markah)

7.

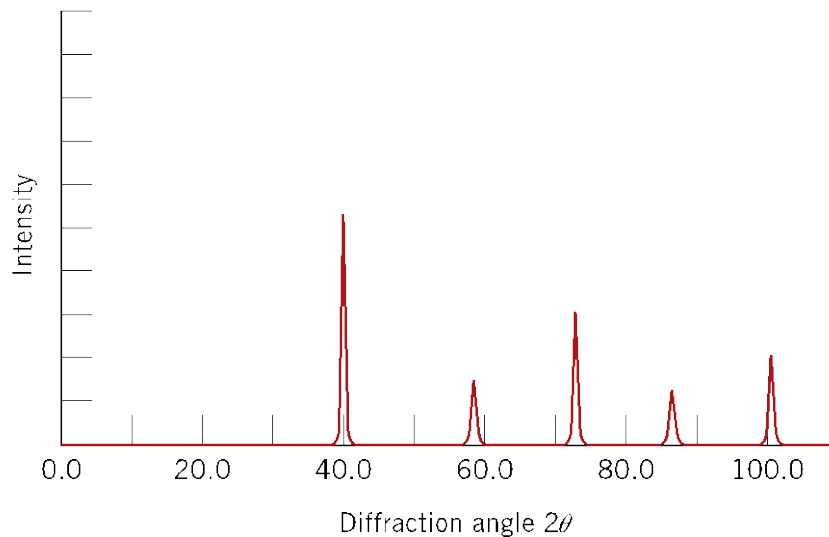


Figure 5 – X-rays diffraction spectrum

Rajah 5 – Spektrum pembelauan sinar-X

Figure 5 shows the first five peaks of the x-ray diffraction pattern for unknown sample, which has a cubic crystal structure; monochromatic x-radiation having a wavelength of 0.1542 nm was used as a source for radiation. The positions of 2θ are 40.2° , 58.4° , 73.3° , 87.0° and 100.7° respectively. Using information given in Figure 5, do the followings:

Rajah 3 menunjukkan lima puncak pertama corak pembelauan sinar-x untuk sampel yang tidak diketahui, yang mempunyai struktur kiub hablur; sinar-x monokromatik yang mempunyai panjang gelombang 0.1542 nm telah digunakan sebagai sumber radiasi. Kedudukan 2θ masing-masing adalah 40.2° , 58.4° , 73.3° , 87.0° dan 100.7° . Menggunakan maklumat-maklumat yang diberikan dalam Rajah 5, lakukan:

- (a) List five-step procedure for determining crystal structure.

Senarai lima langkah prosedur bagi menentukan struktur hablur.

(10 marks/markah)

- (b) Using appropriate table, index each peak with (h, k, l).

Dengan menggunakan jadual yang sesuai, indekskan bagi setiap puncak ini dengan (h, k, l).

(80 marks/markah)

- [c] Suggest, what is the crystal structure (i.e., give SC, BCC or FCC structures) for this unknown sample?

Cadangkan, apakah struktur hablur yang tidak diketahui ini (contohnya SC, BCC atau struktur FCC)?

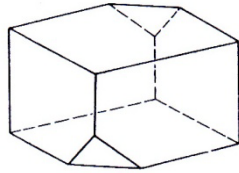
(10 marks/markah)

- oooOooo -

APPENDIX 1

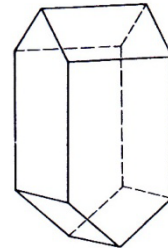
LAMPIRAN 1

3



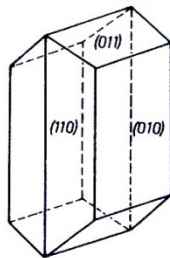
KClO₃

(a)



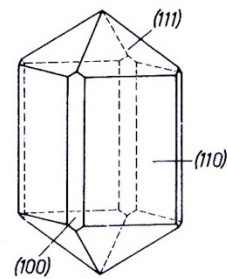
MgSO₄ · 7H₂O (Epsomite)

(b)



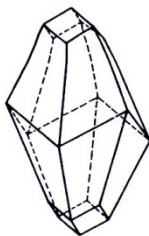
CaCO₃ (Aragonite)

(c)



TiO₂ (Rutile)

(d)



CaCO₃ (Calcite)

(e)