

SULIT



First Semester Examination
2024/2025 Academic Session

February 2025

**EBS209 – Mineralogy
(Mineralogi)**

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of THIRTEEN (13) pages of printed material including ONE (1) APPENDIX before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi TIGA BELAS (13) muka surat yang bercetak termasuk SATU (1) LAMPIRAN sebelum anda memulakan peperiksaan ini].

Instructions : Answer **FIVE (5)** questions. **Part A is COMPULSORY**. Answer **ONE (1) question from Part B, C, D and ONE (1) question from any part**. All questions carry the same marks.

[Arahan : Jawab **LIMA (5)** soalan. **Bahagian A WAJIB dijawab**. Jawab **SATU (1) soalan daripada Bahagian B, C, D dan SATU (1) soalan dari mana-mana bahagian**. Semua soalan membawa jumlah markah yang sama.]

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

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

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PART A / BAHAGIAN A (Compulsory)

- (1). (a). Draw the solid solution triangle and explain the concept of the solid solution in feldspar minerals.

Lukiskan segitiga larutan pepejal dan terangkan konsep larutan pepejal bagi mineral-mineral feldspar.

(10 marks/markah)

- (b). Discuss the physical properties of mineral hematite and mineral magnetite. Calculate the percentage of each element in these minerals.

Bincangkan mineral hematit dan magnetit sifat-sifat fizikal. Kirakan peratusan setiap elemen dalam mineral ini.

(10 marks/markah)

PART B / BAHAGIAN B

(2). (a). Explain the following crystallography terms:

Terangkan kenyataan kristalografi berikut:

(i). Unit cell

Sel unit

(ii). Atomic packing factor

Faktor pemadatan atom

(iii). Weiss parameter

Parameter Weiss

(iv). Crystallography

Kristalografi

(v). Bravais law

Peraturan Bravais

(5 marks/markah)

(b). Elaborate the meaning of point groups in crystallography and their significance. Compare two differences to the space group.

Huraikan maksud kumpulan titik di dalam kristalografi dan kepentingannya.

Bandingkan perbezaannya dengan kumpulan ruang.

(7 marks/markah)

(c). Based on the three-symmetry operation, explain the rules and summarize the Hermann-Mauguin symbol for the tetragonal block ($a=b \neq c$) as shown in Figure 1.

Berdasarkan kepada tiga operasi simetri, terangkan aturan dan ringkaskan symbol Herman-Mauguin bagi blok tetragonal ($a=b \neq c$) seperti di Rajah 1.

(8 marks/markah)

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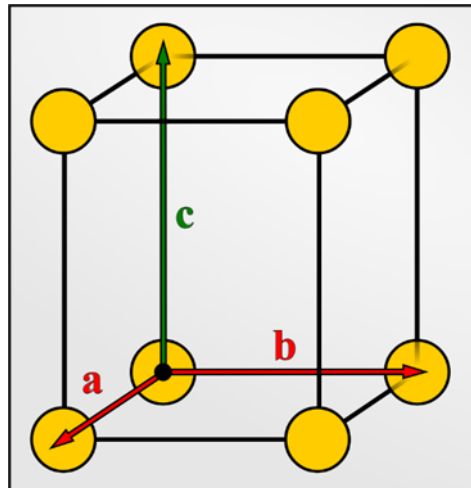


Figure 1: Tetragonal unit cell
Rajah 1: Unit sel tetragonal

- (3). (a) Define the meaning of axial ratios. For hexagonal crystals such as quartz, where there are three axes of equal length (a_1 , a_2 and a_3) perpendicular to the c axis. If $a_1 = a_2 = a_3 = 4.913\text{\AA}$, $c = 5.405\text{\AA}$, calculate the axial ratio for the quartz crystal.

Jelaskan maksud nisbah paksi. Untuk kristal heksagonal seperti kuarza, Dimana terdapat tiga paksi yang sama (a_1 , a_2 , and a_3) seranjang terhadap paksi c . Jika $a_1 = a_2 = a_3 = 4.913\text{\AA}$, $c = 5.405\text{\AA}$, kirakan nisbah paksi untuk kristal kuarza.

(5 marks/markah)

- (b). The cubic and octahedral unit cell as shown in Figure 2 with the axes (a_1 , a_2 , a_3) passes through the center of the unit cell. Write down the Miller Indices for each face of those two unit cells.

Kubus dan oktahedral sel unit seperti ditunjukkan di gambar rajah 2 dengan paksi-paksi (a_1 , a_2 , a_3) melalui di tengah-tengah unit sel. Tuliskan Indeks Miller untuk setiap muka pada setiap sel unit tersebut.

(8 marks/markah)

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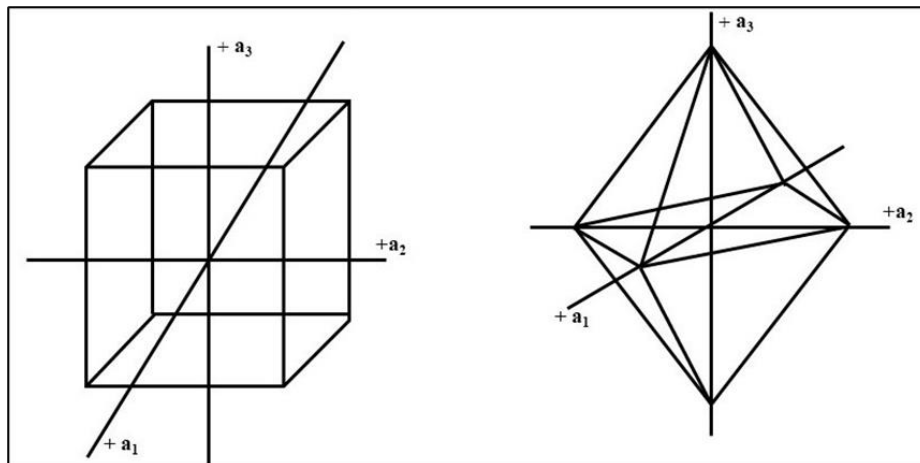


Figure 2: (Left) cubic and (right) octahedral
Rajah 2: (Kiri) kubus and (kanan) oktahedral

- (c). Write the axes name on the hexagon diagram in Figure 3. Determine the Miller Bravais Indices for the plane as in the diagram. Plot another plane for Miller Bravais Indices of $(1\ 1\ -2\ 1)$.

Tuliskan nama paksi - paksi pada gambar rajah heksagon dalam Rajah 3. Tentukan Indeks Miller Bravais bagi satah dalam gambar rajah. Plotkan satu lagi satah untuk Indeks Miller Bravais $(1\ 1\ -2\ 1)$.

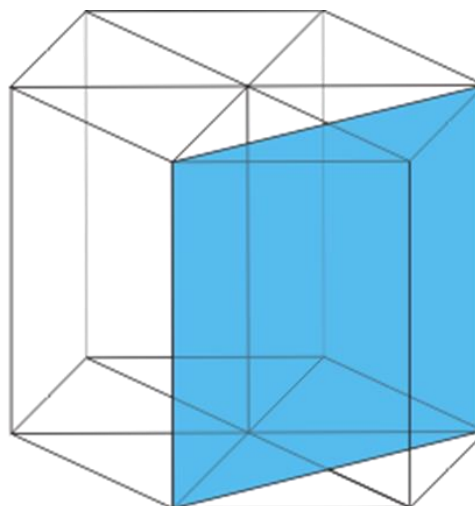


Figure 3: Hexagonal unit cell
Rajah 3: Sel unit heksagon

(7 marks/markah)

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PART C / BAHAGIAN C

- (4). (a). Discuss the following physical properties of minerals, providing examples of minerals that exhibit each property.

Bincangkan sifat-sifat fizikal mineral berikut, berikan contoh - contoh mineral yang mempunyai sifat berikut.

- (i). Hardness
Kekerasan

(5 marks/markah)

- (ii). Colour and Streak
Warna dan corekan

(5 marks/markah)

- (iii). Cleavage and Fracture
Ira dan Pecahan

(5 marks/markah)

- (b). Write the difference between plagioclase and alkali feldspar.

Tuliskan perbezaan di antara feldspar plagioklas dan feldspar alkali.

(5 marks/markah)

- (5). (a). Discuss the difference between sulphate, sulphite and sulphide, of mineral sulphides group.

Bincangkan perbezaan diantara sulfat, sulfit dan sulfida bagi kumpulan mineral sulfida.

(10 marks/markah)

- (b). Determine the valence (charge and number) of the element labeled "X" in each formula below.

Tentukan valensi (cas dan nombor) bagi unsur-unsur berlabel "X" di bawah.

- (i). CaX_2CO_3
- (ii). $\text{LiXSO}_4 \cdot 2\text{H}_2\text{O}$
- (iii). AlXCl_6
- (iv). $\text{ZnXPO}_4 \cdot 3\text{H}_2\text{O}$

From the answers above, explain the meaning of electroneutrality?

Daripada jawapan di atas, terangkan maksud keelektroneutralan?

(3 marks/markah)

- (c). Analysis of sphalerite using X-ray Fluorescence technique is shown in Table 1. Sphalerite may be nearly pure zinc sulfide or, it may contain considerable quantities of iron and minor amounts of manganese and cadmium. This phenomenon is common in minerals, and it can be indicated by writing the **formula** as $(\text{Zn}, \text{Fe})\text{S}$, which shows that total of $\text{Zn} + \text{Fe}$ is 1 with respect to $\text{S}=1$, but actual amounts of Zn and Fe are variable. Calculate mineral formula for both sample.

Analisis sfalerit dengan menggunakan teknik pendafluor sinar-X ditunjukkan dalam Jadual 1. Sfalerit berkemungkinan mempunyai zink sulfida yang hampir tulen atau, mungkin mengandungi sejumlah besar besi dan sejumlah kecil mangan dan kadmium. Fenomena ini biasa berlaku pada mineral, dan dapat ditunjukkan dengan menulis formula sebagai $(\text{Zn}, \text{Fe})\text{S}$, yang menunjukkan bahawa jumlah $\text{Zn} + \text{Fe}$ adalah 1 sehubungan dengan $\text{S}=1$, tetapi jumlah Zn dan Fe sebenarnya berubah-ubah. Kirakan formula mineral bagi kedua-dua sampel.

Table 1: Analysis of sphalerite using X-ray Fluorescence technique
Jadual 1: Analisis sfalerit dengan menggunakan teknik X-ray pendafluor

Element <i>Unsur</i>	Sample 1 (% weight) <i>Sampel 1 (% berat)</i>	Sample 2 (% weight) <i>Sampel 2 (% berat)</i>
Fe	6.99	19.25
Mn	-	1.66
Cd	2.23	1.28
Zn	56.38	43.67
S	33.99	33.57
Total	99.59	99.43

(7 marks/markah)

PART DI BAHAGIAN D

- (6). (a). X-rays with a wavelength of $1.5406 \text{ \AA}$ from a Cu target are diffracted from the (200) planes of a simple cubic crystal. The Bragg angle is 25.3° . If the density of the crystal is 7.87 g/cm^3 , calculate Avogadro's number.

Sinar-X dengan panjang gelombang $1.5406 \text{ \AA}$ dari sasaran Cu telah dibelaukan daripada satah (200) pada hablur kubus ringkas. Sudut Bragg adalah 25.3° . Kirakan nombor Avogadro jika ketumpatan hablur adalah 7.87 g/cm^3 .

(6 marks/markah)

- (b). A metal crystallizes in a face-centered cubic structure with a lattice parameter of 0.352 nm . Calculate the interplanar spacing for the (200) and (220) planes.

Logam menghablur dalam struktur kubus berpusat muka dengan parameter kekisi 0.352 nm . Kira jarak antara satah bagi satah-satah (200) dan (220).

(6 marks/markah)

- (c). X-rays with a wavelength of $1.54 \text{ \AA}$ are diffracted from the (200) planes of a simple cubic crystal. The first-order diffraction peak occurs at a Bragg angle of 25° .

Sinar-X dengan panjang gelombang $1.54 \text{ \AA}$ dibelaukan daripada satah (200) hablur kubus ringkas. Puncak pembelauan tertib pertama berlaku pada sudut Bragg 25° .

- (i). Explain Bragg's Law. How does it relate to the diffraction of X-rays by a crystal lattice?

Terangkan Hukum Bragg. Bagaimanakah ia berkaitan dengan pembelauan sinar-X oleh kekisi hablur?

(2 marks/markah)

- (ii). Draw a simple diagram to illustrate the Bragg diffraction condition. Label the key components, including the incident X-ray beam, the diffracted X-ray beam, the interplanar spacing (d), and the angle of incidence (θ).

Lukis gambar rajah mudah untuk menggambarkan keadaan pembelauan Bragg. Labelkan komponen utama, termasuk insiden alur sinar-X, pembelauan alur sinar-X, jarak antara satah (d), dan sudut insiden (θ).

(2 marks/markah)

- (iii). Calculate the lattice parameter of the crystal.

Kira parameter kekisi hablur

(2 marks/markah)

- (iv). A mineralogist is studying a mineral sample and observes a diffraction peak at a Bragg angle of 30° for the same X-ray wavelength. What can you infer about the interplanar spacing of the mineral compared to the simple cubic crystal? Explain.

Seorang ahli mineralogi sedang mengkaji sampel mineral dan memerhatikan puncak pembelaan pada sudut Bragg 30° untuk panjang gelombang sinar-X yang sama. Apakah yang boleh anda simpulkan tentang jarak antara satah mineral berbanding dengan hablur kubus ringkas? Terangkan.

(2 marks/markah)

- (7). (a). An X-ray diffraction experiment on a spinel (MgAl_2O_4) mineral using X-rays with a wavelength $\lambda = 1.5406 \text{ \AA}$, shows a second-order Bragg peak at an angle $2\theta = 28.4^\circ$. The mineral has a cubic crystal structure. Calculate the lattice parameter 'a' of the cubic unit cell.

Corak pembelaan sinar-X bagi sampel mineral diukur menggunakan sinar-X dengan panjang gelombang $\lambda = 1.5406 \text{ \AA}$. Puncak pembelaan Bragg bagi aturan kedua dari muka selari kekisi kristal diperhatikan pada sudut $2\theta = 28.4^\circ$. Mineral tersebut mempunyai struktur kristal kubus. Kira parameter kekisi 'a' bagi sel unit kubus tersebut.

(6 marks/markah)

- (b). The diffraction pattern of a zinc (Zn) sample was measured with X-ray radiation of wavelength $1.5418 \text{ \AA}$. The first order Bragg diffraction peak was observed at an angle 2θ of 45.0° . Calculate the d-spacing between the diffracting planes in the zinc sample.

Corak pembelaan sampel zink (Zn) diukur dengan sinaran X-ray dengan panjang gelombang $1.5418 \text{ \AA}$. Turutan pertama pembelaan puncak Bragg ditemui pada sudut 2θ sebanyak 45.0° . Kira jarak-d antara satah pembelaan dalam sampel zink

(6 marks/markah)

- (c). Discuss the key operational differences between Wavelength Dispersive X-ray Fluorescence (WD-XRF) and Energy Dispersive X-ray Fluorescence (ED-XRF). Sketch a schematic diagram of both WD-XRF and ED-XRF spectrometers, label the key components.

Bincangkan perbezaan operasi utama antara Pendarfluor Sinar-X Penyebaran Panjang Gelombang (WD-XRF) dan Pendarfluor Sinar-X Penyerakan Tenaga (ED-XRF). Lakarkan gambarajah skema spektrometer WD-XRF dan ED-XRF, labelkan komponen utama.

(8 marks/markah)

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