UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2010/2011

November 2010

EBS 209/3 - Mineralogy
[Mineralogi]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains TEN printed pages before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper consists of SEVEN questions. TWO questions in PART A and FIVE questions in PART B.
[Kertas soalan ini mengandungi TUJUH soalan. DUA soalan di BAHAGIAN A dan LIMA soalan di BAHAGIAN B.]

Instruction: Answer **FIVE** questions. Answer **ALL** questions from PART A and **THREE** questions from PART B. 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 dan **TIGA** soalan dari BAHAGIAN B. 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.]

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PART A

BAHAGIAN A

1. [a] (i) The planes (d_{hkl}) in the crystal are considered to be reflecting planes which can be explained by Bragg's law. Illustrates and write the equation of the said law. What is the Bragg angle (θ) for the plane 222 that has orthorhombic cell edges *a* = 3Å, *b* = 5Å, *c* = 8Å.

Satah-satah (d_{hkl}) bagi suatu hablur dianggap sebagai satah-satah pembalikan yang dapat diungkapkan dengan hukum Bragg. Sila ilustrasi dan tuliskan persamaan bagi hukum tersebut. Apakah sudut Bragg (θ) bagi satah 222 yang mempunyai sisi-sisi sel a = 3Å, b = 5Å, c = 8Å.

(ii) For the cubic crystal of diamond that has a = 3.567Å; Calculate the d-spacing of the (111). Also calculate the d-spacings for plane in orthogonal crystal with cell units of *a*=*b*= 7Å, *c* = 9Å with the Miller indices (1 2 3).

Bagi hablur kubus mineral intan yang mempunyai a = 3.567Å. Kirakan jarak d (jarak antara satah-satah) bagi satah (1 1 1). Kirakan juga jarak-d satah dalam hablur orthogonal dengan unit sel a=b= 7Å, c = 9Å bagi indek Miller (1 2 3).

[b] For the following mineral chemical analyses, determine the mineral formula and their respective names.

Bagi mineral-mineral dengan analisis kimia berikut, tentukan formula dan nama masing-masing.

Mineral A		**Mineral B**	
Oxide *(Oksida)*	Wt%	Oxide *(Oksida)*	Wt%
MgO	57.3	Na_2O	11.81
SiO_2	42.7	Al_2O_3	19.44
		SiO_2	68.74

[c] Define density (S.G.). What are the factors that govern the specific gravity of minerals? Orthoferrosilite ($FeSiO_3$) is an orthorhombic crystal with cell edges *a* = 18.418Å, *b* = 9.078Å, *c* = 5.237Å. Compute its ideal density.

Takrifkan ketumpatan/graviti tentu (S.G.). Apakah faktor yang mengawal ketumpatan tentu sesuatu mineral itu? Orthoferosilit ($FeSiO_3$) adalah hablur ortorombik dengan sisi-sisi a = 18.418Å, b = 9.078Å, c = 5.237Å. Kirakan ketumpatan idealnya.

(20 marks/*markah*)

2. [a] "Definite chemical composition" and "Naturally occurring" are two main components in mineral definition. Explain the terms.

"Komposisi kimia tertentu" dan "Pembentukan semulajadi" adalah dua komponen utama terkandung dalam definasi mineral. Perjelaskan apakah sebenar yang dimaksudkannya.

[b] Minerals have distinguishing physical properties that in most cases can be very useful in determining the identity of the mineral. Amongst others are Hardness and Magnetism properties. Elaborate these properties and usefulness.

Mineral mempunyai sifat-sifat fizikal pembezaan yang dalam kebanyakan kes boleh diguna bagi mengenal/mengecam mineral-mineral. Antaranya ialah kekerasan dan Kemagnetan. Perjelaskan sifat berkenaan dan kepentingannya.

[c] List 3 physical properties that will enable you to differentiate between the following pairs of minerals:

(i) Calcite from quartz
(ii) Pyrite from gold
(iii) Barite from feldspars
(iv) Talc from diamond
(v) Cassiterite from tourmaline

Senaraikan 3 sifat fizikal yang membolehkan kamu membezakan antara pasangan mineral-mineral berikut:

(i) Kalsit dengan kuarza
(ii) Pirit dengan emas
(iii) Barit dengan feldspar
(iv) Talkum dengan intan
(v) Kasiterit dengan turmalin

(20 marks/*markah*)

PART B

BAHAGIAN B

3. [a] What is the minimum potential in kV that is required to excite Cu K-series radiation from a Cu-target X-ray tube? Absorption edge of Cu = 1.380Å. For forsterite a = 4.75; b = 10.20; c = 5.98Å. Calculate 2θ for the (201) lattice spacing for Cukα (λ = 1.5405Å).

Apakah nilai minimum keupayaan dalam kV yang diperlukan bagi menguja radiasi Cu K-siri daripada tiub sinar-X dengan sasaran-Cu. Sisian penyerapan bagi kupram = 1.380Å. Bagi mineral forterite a = 4.75; b = 10.20; c = 5.98Å. Kirakan sudut 2θ bagi satah kekisi (201) bagi Cukα (λ = 1.5405Å).

[b] The mineral pyrope is the magnesian end-member of the garnets. It has the chemical formula $Mg_3Al_2Si_3O_{12}$. Express the weight percents of these appropriate oxides. Meanwhile, pyroxene enstatite ($MgSiO_3$) occurs in three different polymorphs. One of them is clinoenstatite (monoclinic) with cell edges a = 9.605Å, b = 8.813 and c = 5.166, β = 108.46°. Calculate the density of this mineral. Avogadro no. 6.022×10^{23}.

Mineral pirop adalah ahli-akhir magnesia garnet yang mempunyai formula kimia $Mg_3Al_2Si_3O_{12}$. Nyatakan peratus berat oksidanya. Manakala enstatit ($MgSiO_3$) terjadi dalam tiga polimorf berbeza. Salah satunya adalah klinoenstatit (monoklinik) dengan sisi-sisi unit. a = 9.605Å, b = 8.813 dan c = 5.166, β = 108.46°. Kirakan ketumpatan mineral ini. No. Avogadro 6.022×10^{23}.

[c] In accordance to Berzelian system, minerals are classified into silicate and non-silicate based on broad anion size group. Write down those classes and their respective Anion/Anion group with an example.

Berdasarkan kepada sistem pengelasan Berzelian, mineral-mineral diklasifikasikan kepada silikat dan bukan-silikat berasaskan kepada saiz Anion/kumpulan Anion. Tuliskan kelas-kelas berkenaan beserta jenis Anion/Kumpulan Anion beserta contoh-contoh mineral bersesuaian.

(20 marks/*markah)*

4. [a] What is electro neutrality? Determine and write the electro neutrality components for mineral Albite ($NaAlSi_3O_8$), Perovskite ($CaTiO_3$) and Bornite (Cu_5FeS_4).

Apakah itu elektrokeneutralan? Tentu dan tuliskan komponen-komponen keneutralan bagi mineral-mineral Albit ($NaAlSi_3O_8$), Perovskit ($CaTiO_3$) dan Bornite (Cu_5FeS_4).

[b] Define and discuss different categories of tenacity in mineral (metallic and non-metallic).

Takrif dan bincangkan kategori-kategori berlainan "kekukuhan" dalam mineral (logam dan bukan-logam).

[c] The silicate minerals are further subdivided into groups based on the degree of polymerization of the silica tetrahedral. Determine the silicate class of the following minerals.

Mineral-mineral silikat terbahagi kepada sub kumpulan berasaskan kepada polimerisasi tetrahedra silika. Tentukan kelas-kelas silika bagi mineral-mineral berikut:

(1) Beryl ($Be_2Al_2Si_6O_{18}$)
(2) Zircon ($ZrSiO_4$)
(3) Wollastonite ($CaSiO_3$)
(4) Orthoclase ($KAlSi_3O_8$)
(5) Andalusite Al_2SiO_5

(20 marks/*markah)*

5. [a] How minerals got their name? State the name of the mineral class represented by the anion or complex anion below:

Bagaimana mineral diklasifikasikan? Nyata dan namakan kelas mineral yang diwakili oleh anion dan kompleks anion berikut:

(i) $(VO_4)^{-3}$ (ii) $(PO_4)^{-3}$ (iii) $(CO_3)^{-3}$
(iv) $(MoO_4)^{-2}$ (v) $(OH)^{-1}$

[b] Define Axial ratio. What is the axial ratio for mineral quartz and sulphur with the following unit cell dimensions, respectively?

Takrifkan nisbah Paksi. Apakah nisbah paksi bagi mineral kuarza dan sulfur dengan dimensi unit sel seperti berikut?

Quartz $a_1 = a_2 = a_3 = 4.913$ Å and $c = 5.405$ Å,
Kuarza $a_1 = a_2 = a_3 = 4.913$ Å dan $c = 5.405$ Å,

Sulphur $a = 10.47$ Å, $b = 12.87$ Å and $c = 24.39$ Å
Sulfur $a = 10.47$ Å, $b = 12.87$ Å dan $c = 24.39$ Å

(20 marks/*markah)*

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6. [a] Given the following mineral formulas determine the valence (charge and number) of the element labeled "X" in each formula below.

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

(a) $NaXB_5O_6(OH)_6.5H_2O$ (b) $X_3Al_2Si_6O_{18}$

(c) $Mg_3X_2Si_3O_{12}$ (d) $CaAl_2X_2(Al_2Si_2O_{10})$

[b] Determine the formula and name of the following minerals with the given chemical analysis data.

Tentukan formula dan nama mineral silikat dan logam berikut yang mempunyai analisis kimia seperti yang diberikan di bawah.

(1) SiO_2 = 64.8%, Al_2O_3 = 18.3% and K_2O = 16.9 %

(2) FeO : 32.0%, Cr_2O_3 : 68.0%;

[c] State the number of atoms of each element associated with the unit cell of the mineral with the empirical formula:

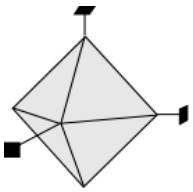
Nyatakan bilangan nombor atom bagi setiap elemen yang berasiosasi dengan sel unit mineral dengan formula ampirikal berikut:

$Cu_3SO_4(OH)_4$ Z = 4

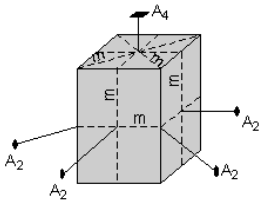
(20 marks/*markah)*

7. [a] Define Steno's law of constancy of interfacial angles. Also note down four basic of symmetries (elements and operation). Write down the symmetry contents, number of faces and type crystal forms for the given crystals.

Definasi hukum Steno mengenai ketetapan sudut-sudut antaramuka. Juga nyatakan empat perkara jenis simetri (unsur dan operasi). Tuliskan kandungan simetri, bilangan muka dan bentuk hablur bagi model Kristal berikut.



(a)



(b)

[b] Write down the general structural formula for silicate minerals and the meaning of the representative symbols. Write down the full and complete chemical formula for minerals with the following chemical data based on the rule/customary.

Tuliskan formula struktur umum bagi mineral-mineral silikat dan maksud untuk setiap symbol. Tuliskan formula kimia yang penuh dan lengkap bagi mineral-mineral silikat berikut dengan data kimia berikut berasaskan kepada peraturan/kebiasaan itu.

(i) O Zn 2Fe

(ii) 4 (OH) Si_2O_5 2Al

(iii) (Si_2O_6) Ca Mg, Fe (replacement/*gantian)*

(iv) (OH) (Si_2O_7) $2H_2O$ 4Zn

(v) 2Al Si_2O_7 2Ca FeO (OH) SiO_4

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[c] Draw a schematic diagram to classify the major mineral groups based on their chemical composition. Name three (3) minerals in the carbonate group and three (3) minerals in the mica (sheet structure silicate) group.

Lakar rajah skema bagi mengkelasifikasikan kumpulan mineral utama berasaskan kepada komposisi kimia. Namakan tiga (3) mineral dalam kumpulan karbonat dan tiga(3) lagi dalam kumpulan silikat.

(20 marks/*markah*)

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