UNIVERSITI SAINS MALAYSIA

First Semester Examination
2015/2016 Academic Session

December 2015 / January 2016

EBS 209/3 - Mineralogy
[Mineralogi]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains <u>FOURTEEN</u> printed pages before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi <u>EMPAT BELAS</u> muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

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

<u>Instruction</u>: Answer <u>FIVE</u> questions. Answer <u>ALL</u> questions from PART A and <u>THREE</u> questions from PART B. If a candidate answers more than five questions only the first five questions answered in the answer script would be examined.
[<u>Arahan</u>: Jawab <u>LIMA</u> soalan. Jawab <u>SEMUA</u> soalan dari BAHAGIAN A dan <u>TIGA</u> 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 in the examination questions, the English version shall be used.
[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

PART A / *BAHAGIAN A*

1. [a] Define Miller Index? What are the Miller Index of the following faces of a forms that having the following Weiss parameters?

    (i)   6a :1/4b : 3c minus

    (ii)   1/2a (minus) : 1/4b : infinity c.

    (ii)   4a:3a:9a

    (iv)   3/2a : 4/5b : 6/11c

    Takrifkan Indeks Miller? Apakah nilai Indeks Miller bagi muka-muka sebuah bentuk yang mempunyai parameter Weiss seperti berikut?

    (i)   6a :1/4b : 3c minus

    (ii)   1/2a (minus) : 1/4b : infiniti c.

    (iii)   4a:3a:9a

    (iv)   3/2a : 4/5b : 6/11c

    (30 marks/*markah*)

    [b] Calculate the formula (all water as yH_2O) for a mineral which has the following element oxide weight % composition.

    Na_2O = 22.7%, B_2O_3 = 51.0% H_2O = 26.3%.

    Also, determine all possible mineral formulas with different water compositions. If the $(OH)x : yH_2O$ or $x : y$ =2 : 3 , what would be the correct formula for the mineral?.

    Kirakan formula (air sebagai yH_2O) bagi suatu mineral yang mempunyai komposisi peratusan (%) berat unsur oksida seperti berikut

    Na_2O = 22.7% , B_2O_3 = 51.0% H_2O = 26.3%.

    Tentukan juga kemungkinan formula-formula mineral lain dengan komposisi air berbeza. Sekiranya (OH) x : yH_2O or x : y =2 : 3 or 4 : 6. Apakah sepatutnya formula yang betul bagi mineral ini?.

    (30 marks/*markah*)

[c] (i) Define density (S.G). What are the factors that governed the specific gravity of minerals? If the common sulfide mineral pyrite (FeS_2) has a density of $5.02g/cm^3$ and a unit cell edge of $5.42Å$. Calculate the Z, the number of formula units per cell.

Takrifkan ketumpatan/graviti tentu (S.G). Apakah faktor yang mengawal ketumpatan tentu sesuatu mineral itu? Sekiranya mineral sulfida yang lazim pirit (FeS_2) mempunyai ketumpatan 5.02 g/cm3 dan sisian sel unit 5.42Å. Kirakan nilai Z, iaitu bilangan unit-unit formula per sel.

(ii) Calculate the specific gravity of a mineral with the following information given: Composition BeO = 19.8%, Al_2O_3 = 80.2%, Z = 4.

Axial dimension of unit cell a= 5.47 Å, b : 9.39 Å   c = 4.42 Å

Kirakan graviti tentu bagi mineral dengan maklumat diberikan seperti berikut: Komposisi BeO = 19.8%, Al_2O_3 = 80.2%, Z = 4.

Dimensi Kepaksian Unit Sel a = 5.47 Å, b : 9.39 Å   c = 4.42 Å

(40 marks/*markah*)

2. [a] (i) Briefly discuss what do polymorphism means in mineralogy? State the name of the mineral class represented by the anion or complex anion below with appropriate instance?

Secara ringkas bincangkan maksud polimerfisma dalam mineralogi? Nyata dan namakan kelas mineral yang diwakili oleh anion dan kompleks anion berikut dengan contoh mineral bersesuaian?

(i) $(VO_4)^{-3}$

(ii) $(PO_4)^{-3}$

(iii) $(CO_3)^{-3}$

(iv) $(MoO_4)^{-2}$

(v) $(OH)^{-1}$

(ii) Silicate minerals is the most abundance minerals and has been classified in accordance the structures how atoms of silicon and oxygen packed together, i.e. tetrahedral is shared to form silicate structures like island or ring. Given below are the formulas of some silicate minerals, and please determine its silicate group and its mineral name?

Mineral silikat adalah mineral yang terbanyak dan diklasifikasikan menurut struktur-struktur bagaimana atom-atom silicon dan oksigen digabungkan, iaitu tetrahedral dikongsikan bagi membentuk struktur silikat seperti berbentuk pulau dan cincin. Diberikan di bawah formula sekumpulan mineral silikat. Tentukan jenis kumpulan silikat tersebut serta namanya?

(i) $Ca_2(Fe^{+3},Al)Al_2(SiO_4)(Si_2O_7)(OH)$

(ii) $Be_3Al_2Si_6O_{18}$

(iii) $Ca(Mg,Fe)Si_2O_6$

(iv) $K(Mg,Fe)_3(AlSi_3)O_{10}(OH)_2$

(40 marks/*markah*)

...5/-

[b]   Calculate the weight percent of each element (cation) oxides for the empirical formula of the mineral below.

(i) $MgAl_2O_4$ (Spinel)

(ii) $K(AlSiO_8)$ (Felsdpar)

(iii) Mg_2SiO_4 (Olivin)

(Atomic weight: Mg :24.31, Al : 26.98; K :39.10).

Determine the valencey of the following element listed as "X" in each formula.

(i) $LiX(Si_2O_6)$

(ii) $Pb(XO_4)$

Kirakan peratus berat setiap element (kation) oksida bagi formula empirikal mineral di bawah?

(i) $MgAl_2O_4$ (Spinel)

(ii) $K(AlSiO_8)$ (Felsdpar)

(iii) Mg_2SiO_4 (Olivin)

Berat atom (g) : Mg :24.31, Al : 26.98; K :39.10.

Tentukan valensi bagi unsur-unsur yang ditandakan sebagai "X" dalam setiap formula di bawah

(i) $LiX(Si_2O_6)$

(ii) $Pb(XO_4)$

(30 marks/*markah*)

[c]   Define luster in mineral, categories of lusters or common mineral luster types with appropriate mineral examples?

Takrif apa itu kilauan bagi mineral, kategori atau jenis-jenis kilauan lazim mineral beserta dengan contoh-contoh mineral bersesuaian?

(30 marks/*markah*)

PART B / *BAHAGIAN B*

3.   Answer all the following questions (*Jawab kesemua soalan berikut*)

[a]   X-ray Diffiraction (XRD) technique is widely used to study the structure of mineral crystal.   By using appropriate diagram, please show and derive the Bragg's Law. A different pattern of a mineral is obtained by using x-rays with wavelength $\lambda = 0.709$ Å. The second-order Bragg diffraction from the parallel faces of the cubic unit cells is observed at the angle $2\theta = 20.2°$. Calculate the lattice parameter a.

Husmanite ($MnMn_2O_4$) has tetragonal cell edges a = 5.76 Å , c = 9.44; Z = 4. Calculate 2θ for CuK_α radiation = 1.5405A for the following direction, (101) and (021).

Teknik pembelauan Sinar X digunakan secara meluas untuk mengkaji struktur hablur mineral. Dengan rajah bersesuaian sila tunjuk dan terbitkan hukum Bragg. Satu corak mineral telah diperolehi menggunakan Sinar-X dengan $\lambda = 0.709$ Å.   Order kedua belauan Bragg daripada muka-muka selari sel-sel unit kubus telah diperhati pada sudut 20.2°. Kirakan parameter kekisi, a.

Husmanit ($MnMn_2O_4$) mempunyai sisi-sisi sel tetragonal a = 5.76 Å, c = 9.44Å; Z = 4.   Kirakan sudut 2θ untuk radiasi CuK_α = 1.5405A dalam arah-arah (101) dan (021) berikut?

(40 marks/*markah*)

[b]   Define specific gravity (S.G) of mineral, and how S.G. of mineral crystal is determined, and what are the factors that governed the S.G of mineral?

Takrifkan graviti tentu (S.G) bagi mineral dan bagaimana S.G. hablur mineral ditentukan, dan apakah faktor yang mengawal S.G. mineral?

(30 marks/*markah*)

[c]   How do you differentiate or recognize the following minerals based on specific physical properties of minerals (e.g. hardness, specific gravity, colour, streak, luster etc). What are the chemical formulas of those minerals?

(i)   Gold
(ii)   Calcite
(iii)   Pyrite
(iii)   Magnetite

Bagaimana anda membezakan atau mengecam mineral-mineral berikut berdasarkan sifat-sifat fizikal lazim mineral (contoh : kekerasan, graviti tentu, warna, goresan, kilauan dll?.

(i)   Emas
(ii)   Kalsit
(iii)   Pirit
(iv)   Magnetit

(30 marks/*markah*)

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

Mineral pirop adalah ahli-akhir magnesia garnet yang mempunyai formula kimia $Mg_3Al_2Si_3O_{12}$. Nyatakan peratus berat oksidanya. Manakala enstatit (MgSiO₃) terjadi dalam tiga polimorf berbeza. Salah satunya adalah klinoenstatit (monoklinik) dengan sisi-sisi unit. a = 9.605 Å, b = 8.813 and c = 5.166, β= 108.46° Kirakan ketumpatan mineral ini.   No. Avogadro ialah 6.022 x 10^{+23}.

(40 marks/*markah*)

[b] Briefly discuss the composition of the earth crust, and factors or geological environments that governs the process of minerals formation.

Secara ringkas terangkan mengenai komposisi kerak bumi serta faktor-faktor atau persekitaran geologi yang mengekang proses pembentukan mineral.

(30 marks/*markah*)

[c] State the number of atoms of each element associated with the unit cell of the following mineral with the empirical formula $Cu_3SO_4(OH)_4$ Z = 4.

Nyatakan bilangan atom-atom bagi setiap unsur yang berasosiasi dengan unit sel mineral yang berformula empirikal $Cu_3SO_4(OH)_4$ Z = 4.

(30 marks/*markah*)

5. [a] What is electro neutrality? Determine and write the electro neutrality components for mineral Titanite ($CaTiSiO_5$), Perovskite ($CaTiO_3$) and Fosterite (Mg_2SiO_4).

Apakah itu ke elektronutralan? Tentu dan tuliskan komponen-komponen kenutralan bagi mineral Titanit ($CaTiSiO_5$), Perovskit ($CaTiO_3$) and Fosterit (Mg_2SiO_4)?

(30 marks/*markah*)

[b] Define and discuss different categories of luster in mineral (metallic and non-metallic), and its relationship to mineral's refractive index?.

Takrif dan bincangkan kategori berbeza kilauan bagi mineral (logam dan bukan logam), dan hubungkaitnya dengan indeks biasan?

(30 marks/*markah*)

[c]   Determine the formulas and identity of these minerals which possessed the following compositions?

   (i) SiO_2 : 51.5%, FeO : 30.8%, MgO : 17.7%

   (ii)   Mn : 63.2%, O : 36.8%

   (iii)   Fe : 72.4%, O : 27.6%

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

(Given Atomic weight : Mn : 54.9, Cr : 51.9)

Tentukan formula dan identiti mineral-mineral yang mempunyai komposisi kimia seperti berikut?

   (i) SiO_2 : 51.5%, FeO : 30.8%, MgO : 17.7%

   (ii)   Mn : 63.2%, O : 36.8%

   (iii)   Fe : 72.4%, O : 27.6%

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

Diberikan Berat atom : Mn : 54.9, Cr : 51.9

(40 marks/*markah*)

6.   [a]   Discuss on crystal habit?. Describe and Illustrate the appearances of the following crystal habits of *tabular, fibrous, dendritic* and *botryoidal*.

Bincangkan Kristal habit?. Terangkan dan ilustrasi rupa bagi hablur-hablur tabular, dentritik dan botroidal.
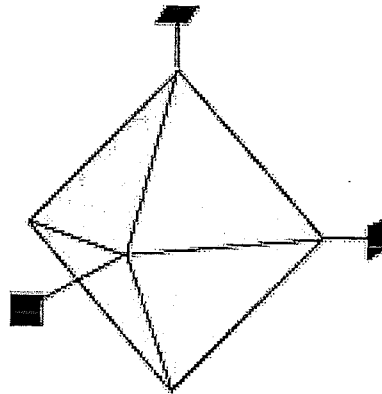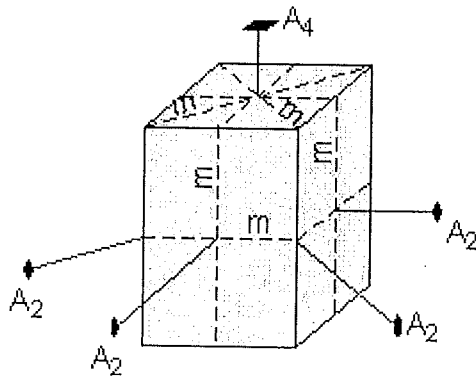
(40 marks/*markah*)

[b]   Define the minerals? Elaborates the meaning of "Homogeneous" and "Definite chemical composition".

Takrif mineral? Perjelaskan maksud "Kohomogean" dan "Komposisi kimia tentu".

(30 marks/*markah*)

[c]   Note down four basic of symmetries (elements and operation). Write down the symmetrical contents, number of faces and type crystal forms for the given crystals?

Tuliskan empat asas simetri (unsur dan operasi). Tuliskan kandungan simetri, sistem hablur bilangan muka, sistem hablur dan jenis bentuk kristal bagi kristal berikut?

(30 marks/*markah*)

7.   [a]   What is X-ray? What is the minimum potential in kV is required to produce K-series radiation from a Cu-target X-ray tube. Given light velocity (c) 3.0×10^8 m/s; 1 electron volt=1.6016 $\times10^{19}$ joule; Planck's constant=6.6 $\times10^{-34}$ joule-second. Adsorption edge of Cu=1.380Å.

Apakah itu X-ray? Apakah keupayaan minimum dalam kV yang diperlukan untuk menguja radiasi K-series daripada sebuah tiub sinar-X sasaran kuprum. Diberikan bahawa halaju cahaya (c) 3.0 x 10^8 m/s; 1 electron volt=1.6016 $x10^{19}$ joule; Pemalar Planck's =6.6 $x10^{-34}$ joule-second. Nilai serapan sisi kuprum ialah Cu=1.380Å.

(40 marks/*markah*)

[b]   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:

(i) $Mg_3X_2Si_3O_{12}$

(ii) $X_3Al_2Si_6O_{18}$

(iii) $CaAl_2X_2(Al_2Si_2O_{10})$

(iv) $Al_6XPO_4(OH)_8.2H_2O$

Given P= +5

Diberi P= +5

(30 marks/*markah*)

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

Tentukan formula dan nama kimia mineral yang mempunyai analisis kimia seperti di bawah.

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

(ii)   FeO=32.0%, Cr_2O_3=68.0%

Atomic Weight Cr : 51.9

Berat Atom Cr : 51.9

(30 marks/*markah*)