

**SULIT**



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA  
FINAL EXAMINATION  
SEMESTER I  
SESSION 2011/2012**

**COURSE NAME : MATERIAL SCIENCE**

**COURSE CODE : BDA 1602**

**PROGRAMME : 3 BEE/4 BEE**

**EXAMINATION DATE : JANUARY 2012**

**DURATION : 2 HOURS**

**INSTRUCTION : PART A : ANSWER ALL  
QUESTIONS  
PART B : ANSWER TWO (2)  
QUESTIONS ONLY**

**THIS PAPER CONTAINS EIGHT (8) PAGES**

**SULIT**

**PART A**

- Q1 (a)** How many atoms per unit cell and what is the coordination number in the Body Centered Cubic (BCC) crystal structure? Define the relationship between the lattice constant,  $a$  of the BCC unit cell and the radius of each atoms.  
(9 marks)
- (b)** Molybdenum at 20°C is Body Centered Cubic (BCC) and has an atomic radius of 0.140 nm. Calculate a value for its lattice constant,  $a$  in nanometers.  
(8 marks)
- (c)** Calculate the linear atomic density  $\rho_l$  in the [110] direction in the copper crystal lattice in atoms per millimeter. Copper is FCC and has a lattice constant of 0.361 nm.  
(8 marks)
- Q2 (a)** Unit cell for Urbium (Ub) is a simple cubic. Determine the crystal structure of Ub if the molar volume,  $V_{\text{mol}} = 9.41 \text{ cm}^3/\text{mol}$  and lattice constant  $a = 3.15 \text{ \AA} = 3.15 \times 10^{-8} \text{ cm}$   
(9 marks)
- (b)** Calculate the linear density of atoms along [011] in lithium (Li). Lithium has a BCC crystal structure. The value of the lattice constant in Li is 3.51 Å. Express your answer in units of atoms/Å.  
(8 marks)
- (c)** Sketch the crystallographic directions and planes in **Figure Q2**.  
*Please enclose **Figure Q2** with your answer script.*
- |                    |                           |
|--------------------|---------------------------|
| (i) [321]          | (iii) $[1\bar{1}\bar{1}]$ |
| (ii) $(20\bar{1})$ | (iv) $(30\bar{2})$        |
- (8 marks)

**PART B**

- Q3** (a) How do you distinguish the following behaviors of a material? Support your statement with a stress-strain diagram.
- (i) Material that behaves elastically.  
(ii) Material that behaves plastically. (10 marks)
- (b) Calculate the engineering stress in SI units on a 15 cm long steel bar and having a cross section of 4.25 mm × 12.0 mm that is subjected to a load of 5000 kg. If the Young's Modulus of the steel bar is 2000 MPa ( $E = 2000 \text{ MPa}$ ), estimate the deformation,  $\delta$  of the steel bar when it is subjected to the same load. (15 marks)
- Q4** (a) Distinguish between a substitutional solid solution and an interstitial solid solution. Use appropriate diagram to explain your answer. (10 marks)
- (c) Calculate the time,  $t$  for diffusion by referring to **Figure Q4 (a)**. (15 marks)
- Q5** By referring to Pb-Sn system in **Figure Q5**,
- (a) State the type of invariant reaction occurs and gives the related equation. (3 marks)
- (b) Perform a phase analysis for Pb-Sn alloy with composition of 30-wt% Sn at  $183 + \Delta T \text{ }^\circ\text{C}$ . (10 marks)
- (c) Calculate the weight percentage of  $\alpha$  eutectic for eutectic composition  $183 - \Delta T \text{ }^\circ\text{C}$ . Suppose total alloy composition is 100 gram. (8 marks)
- (d) Sketch and label all microstructures for the solidification of 70-wt% Pb alloy. (4 marks)

(Lampiran soalan dalam Bahasa Melayu))

**BAHAGIAN A**

**S1** (a) Nyatakan bilangan atom per sel unit dan nombor kooordinat bagi struktur hablur kiub berpusat jasad. Jelaskan hubungan pemalar kekisi,  $a$  bagi sel unit kiub berpusat jasad dan jejari setiap atom. (9 markah)

(b) Unsur Molibdenum adalah berstruktur kiub berpusat jasad dan mempunyai jejari atom 0.140nm pada suhu 20°C. Hitungkan nilai bagi pemalar kekisi,  $a$  dalam unit nanometer. (8 markah)

(c) Kirakan ketumpatan atom linear  $\rho_l$  pada arah [110] dalam kekisi hablur kuprum dalam unit atom per millimeter. Kuprum mempunyai sel unit kiub berpusat muka dan pemalar kekisi adalah 0.361 nm. (8 markah)

**S2** (a) Sel unit bagi Urbiium (Ub) adalah kiub mudah. Tentukan struktur hablur Ub jika isipadu molar,  $V_{\text{mol}} = 9.41 \text{ cm}^3/\text{mol}$  dan pemalar kekisi,  $a = 3.15 \text{ \AA} = 3.15 \times 10^{-8} \text{ cm}$ . (9 markah)

(b) Kirakan ketumpatan linear atom di [011] dalam unsur lithium (Li). Lithium mempunyai struktur hablur kiub berpusat jasad. Nilai pemalar kekisi bagi Li adalah 3.51 Å. Jawapan hendaklah dalam unit atoms/Å. (8 markah)

(c) Lakarkan arah-arah dan satah-satah berikut di dalam **Rajah S2**.  
*Kepilkan **Rajah S2** bersama skrip jawapan anda.*

- |                    |                                 |
|--------------------|---------------------------------|
| (i) [321]          | (iii) $[\bar{1}\bar{1}\bar{1}]$ |
| (ii) $(20\bar{1})$ | (iv) $(30\bar{2})$              |

(8 markah)

**BAHAGIAN B**

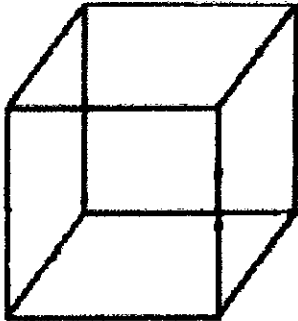
- S3 (a) Perihalkan sifat-sifat bahan yang dinyatakan di bawah.  
Lakarkan gambarajah tegasan-terikan bagi menyokong penjelasan anda.  
(c) Bahan yang bersifat elastik.  
(ci) Bahan yang bersifat plastik.  
(10 markah)
- (b) Kirakan tegasan kejuruteraan dalam unit SI pada bar keluli yang mempunyai panjang 15 cm dan keratan rentas, 4.25 mm × 12.0 mm yang dikenakan beban 5000 kg. Jika Modulus Young bagi bar keluli tersebut adalah 2000 MPa ( $E = 2000 \text{ MPa}$ ), kirakan nilai pemanjangan,  $\delta$  pada bar keluli tersebut apabila dikenakan beban yang sama.  
(15 markah)
- S4 (a) Perihalkan perbezaan di antara larutan pepejal gantian dan larutan pepejal celahan. Gunakan rajah yang sesuai dalam penjelasan anda.  
(10 markah)
- (b) Hitungkan masa,  $t$  untuk resapan dengan merujuk kepada **Rajah S4 (a)**.  
(15 markah)
- S5 Berdasarkan kepada gambarajah fasa sistem Pb-Sn dalam **Rajah S5**,
- (a) Nyatakan jenis tindakbalas tak varian yang berlaku beserta persamaan yang berkaitan.  
(3 markah)
- (b) Lakukan analisis fasa bagi aloi Pb-Sn dengan komposisi 30 wt% Sn pada suhu  $183 + \Delta T \text{ }^\circ\text{C}$ .  
(10 markah)
- (c) Hitungkan berat eutektik  $\alpha$  bagi komposisi eutektik pada  $183 - \Delta T \text{ }^\circ\text{C}$ .  
Andaikan jumlah komposisi aloi ialah 100 gram.  
(8 markah)
- (d) Lakar dan labelkan semua mikrostruktur bagi pemejalan aloi 70 wt% Pb.  
(4 markah)

**FINAL EXAM / PEPERIKSAAN AKHIR**

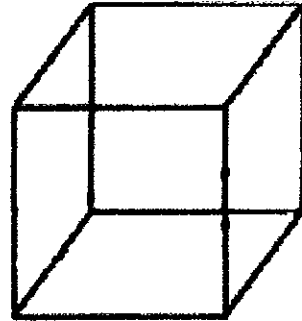
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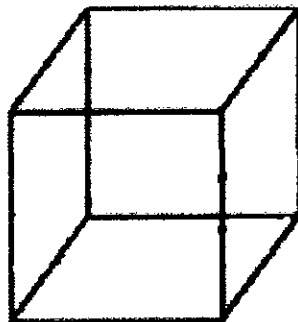
(i)  $[321]$



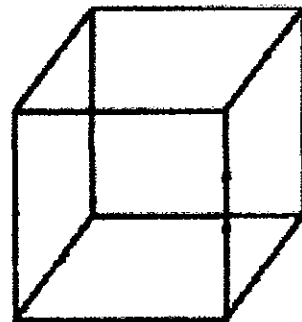
(iii)  $[\bar{1}\bar{1}\bar{1}]$



(ii)  $(20\bar{1})$



(iv)  $(30\bar{2})$

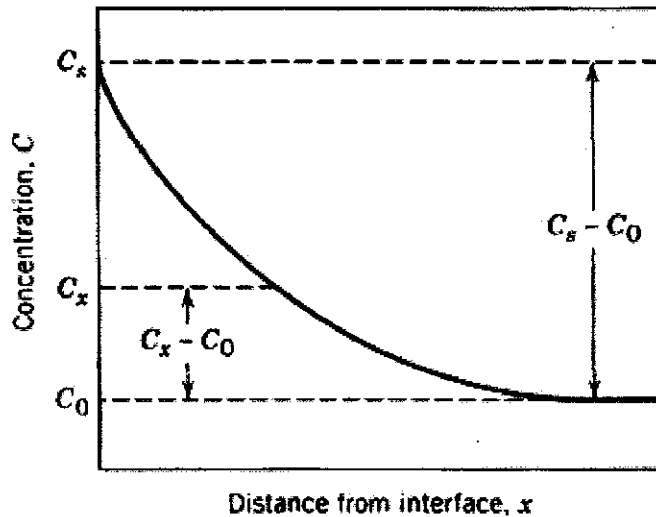


**Figure Q2 / Rajah S2**

**FINAL EXAM / PEPERIKSAAN AKHIR**

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Given:

- $C_s = 0.25 \%$
- $C_x = 0.10 \%$
- $C_o = 0 \%$
- $x = 0.1 \text{ mm}$
- $D = 1.6 \times 10^{-11} \text{ m}^2/\text{s}$

**Figure O4(a) / Rajah S4(a)**

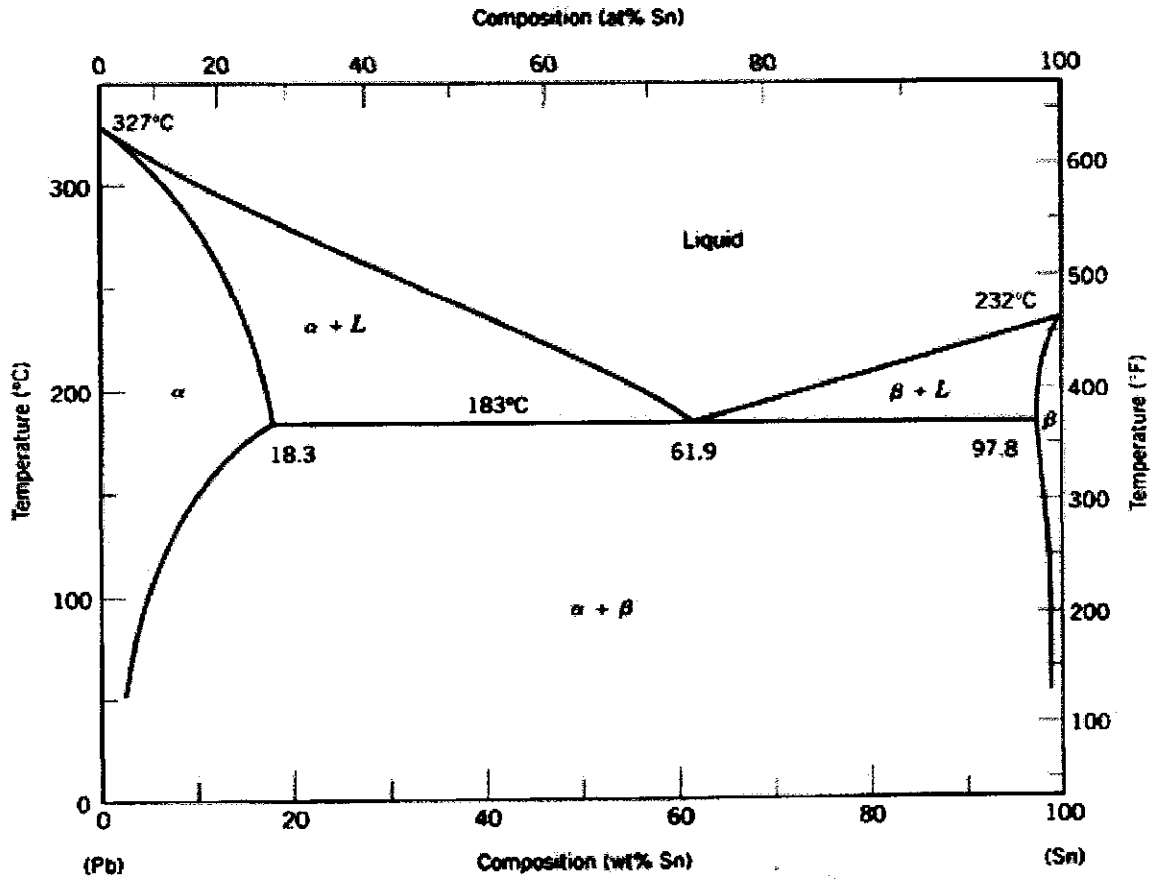
$z$	$erf(z)$	$z$	$erf(z)$	$z$	$erf(z)$
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9523
0.05	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	2.0	0.9953
0.35	0.3794	0.95	0.8209	2.2	0.9981
0.40	0.4284	1.0	0.8427	2.4	0.9993
0.45	0.4755	1.1	0.8802	2.6	0.9998
0.50	0.5205	1.2	0.9103	2.8	0.9999

**Figure O4(b) / Rajah S4(b)**

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**Figure Q5 / Rajah S5**