UNIVERSITY OF WOLLONGONG IN DUBAI

Section A: Example Questions		
For full marks: Show clearly written calculations below/or in answer booklet and mark data points on the graph in figure 1		
Marks	**Section A: Example Question**	**Final Answers**
	Question 1 Using the **phase diagram** for the aluminium-copper **Alloy** binary system shown in **figure 1**, answer the following questions: **[a]** What phases are present at 600°C, **15wt% Cu**? **[b]** What is the composition of each phase from part (a), in wt% Cu? **[c]** What is the fraction of liquid phase at 600°C and **15wt% Cu** ? **[d]** At what temperature does an alloy material of **45 wt% Cu** begin to start melting? **[e]** At what temperature does an alloy material of **3 wt% Cu** begin to start solidifying? **[f]** What is the **eutectic** temperature and composition for the Al-Cu system?	

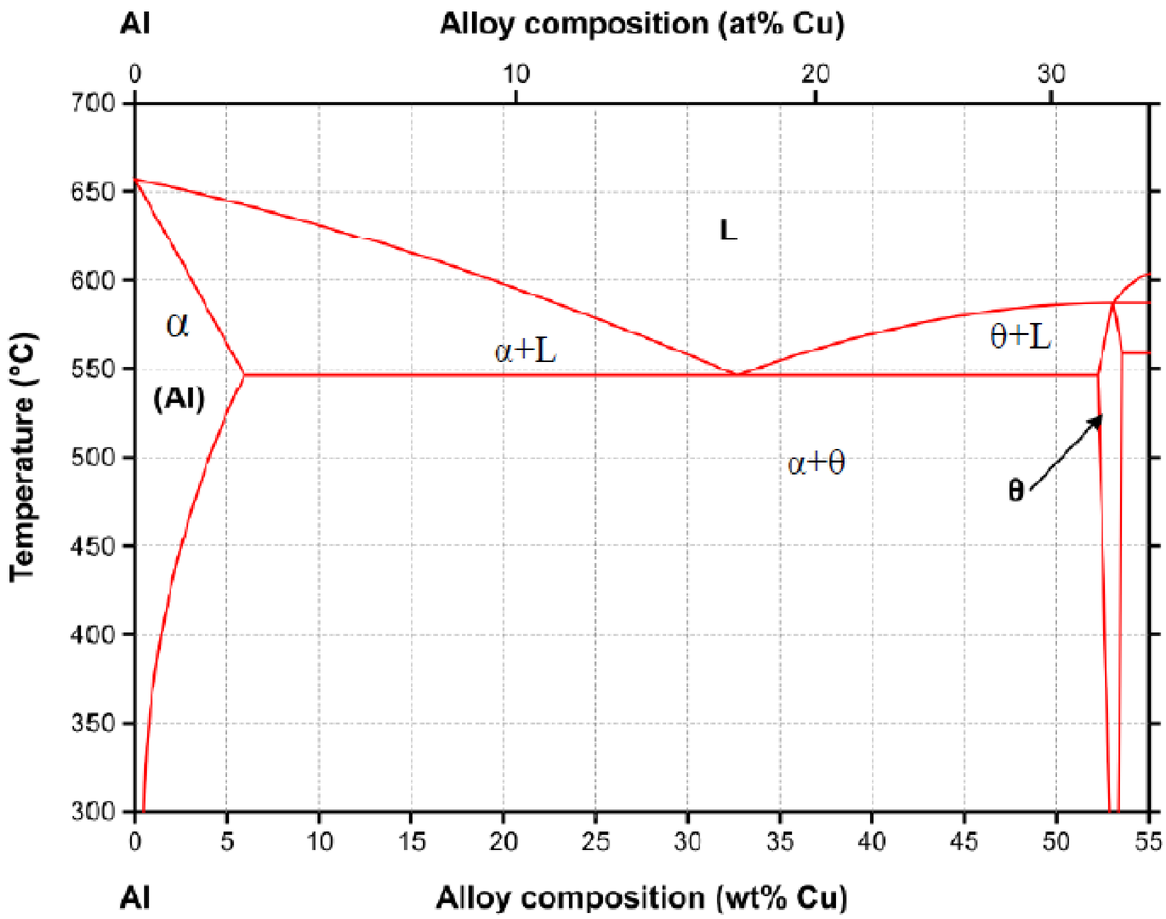
Al
Alloy composition (at% Cu)
0
10
20
30
700
650
600
550
500
450
400
350
300
Temperature (°C)
L
α
(Al)
α+L
θ+L
α+θ
θ
0
5
10
15
20
25
30
35
40
45
50
55
Al
Alloy composition (wt% Cu)

Figure 1:

Section A: Example Questions

Question 2

[a] Block of cast iron has dimensions of 35 *mm* by 24 *mm* by 18 *mm* and is at temperature of 12°C. Determine the increase in volume when the temperature of the block is raised to 67°C.

Assume the coefficient of linear expansion of cast iron to be 11×10^{-6} K^{-1}.

[b] To what temperature would 15kg of an aluminium specimen at 23°C be raised if 115 kJ of heat is supplied?

[c] A manhole cover has a diameter of 0.95m at 23$°C$. The cover is made of a copper/zinc alloy with a coefficient of linear expansion of 2.6 x 10^{-5} K^{-1} and Young's Modulus of 112GPa.

What temperature does the stress (σ) reach -142.68 MPa?

[d] A Polyvinylchloride (PVC), sample was found to have the following molecular weight distribution described in **Table 1.** m=62.5g/mol.

Table 1: Molecular weight distribution data

Number fraction	Weight fraction	Molecular weight Range $g.mol^{-1}$
x_i	w_i	M
0.05	0.02	12,000 - 16,000
0.16	0.11	16,000 -24,000
0.21	0.20	24,000 - 32,000
0.25	0.26	32,000 - 40,000
0.20	0.23	40,000 – 48,000
0.13	0.18	48,000 – 56,000

i. Calculate the number average and weight average molecular weights.

ii. Calculate the number average and weight average degree of polymerisation.

(i)

(ii)

Section A: Example Questions

For full marks: Show clearly written calculations below/or in answer booklet

Marks

Section B: Example Question

Question 1

Final Answers

A continuous and aligned fiber–reinforced composite is to be produced consisting of 35 vol% Kevlar fibers and 65 vol% polyester matrix; the mechanical characteristics of these two materials are as follows:

Table 2: Composite material properties

	Modulus of Elasticity (GPa)	**Tensile Strength** (MPa)
Kevlar fiber	130	3720
Polyester	3.2	55.2

The composite has a cross-sectional area of 185 mm^2 and is subjected to a longitudinal load of 22 kN.

[a] Calculate the modulus of elasticity of this composite where loading is applied in the longitudinal direction of the fibres

[b] Calculate the fiber–matrix load ratio.

[c] Calculate the actual loads carried by both fiber and matrix phases.

[d] Compute the magnitude of the stress on each of the fiber and matrix phases.

[e] What strain is experienced by each phase?

Section B: Example Questions

Question 2

[f] For intrinsic silicon, the electrical conductivity at room temperature is 4.39×10^{-4} *S/m*. If the charge of an electron is -1.602×10^{-19} *C*, and the electron and hole mobilities are 0.14 $m^2/V.s$ and 0.05 $m^2/V.s$ respectively:

Calculate the intrinsic carrier concentration (n_i) of the silicon at room temperature (25℃).

(a) A gold wire 2.5 mm in diameter is to offer a resistance of no more than 2.4 Ω. Using the data in Table 3, compute the maximum wire length.

Table 3: Room-Temperature Electrical Conductivities for Nine Common Metals and Alloys

Metal	*Electrical Conductivity* $[(\Omega \cdot m)^{-1}]$
Silver	6.8×10^7
Copper	6.0×10^7
Gold	4.3×10^7
Aluminum	3.8×10^7
Brass (70 Cu–30 Zn)	1.6×10^7
Iron	1.0×10^7
Platinum	0.94×10^7
Plain carbon steel	0.6×10^7
Stainless steel	0.2×10^7

$E_{cl} = E_m V_m + E_f V_f$	$A_f = V_f A$ $A_m = V_m A$
$\frac{F_f}{F_m} = \frac{E_f V_f}{E_m V_m}$	$\Delta l = \alpha l_0 \Delta T$
$\sigma = \frac{1}{\rho}$	$\sigma = -E\alpha_l \Delta T$ $\sigma = E\alpha_l (T_o - T_f)$
$R = \frac{V}{I}$	$\rho = \frac{RA}{l}$
$P = \frac{V^2}{R}$	$\sigma = \lvert q \rvert n(\mu_n)$
$\sigma = \lvert q \rvert p(\mu_p)$	$\sigma = \lvert q \rvert n_i(\mu_n + \mu_e)$
$C = \left(\frac{Q}{m\Delta T}\right)$	$DP = \frac{\bar{M}}{m_a}$
$\bar{M}_n = \sum_i x_i M_i$	$r = d\sqrt{N}$ $L = Nd.\sin\left(\frac{\theta}{2}\right)$
$\bar{M}_w = \sum_i w_i M_i$	$W_L = \frac{C_\alpha - C_0}{C_\alpha - C_L}$