APS104S – Introduction to Materials & Chemistry

Lecture 38

April 8, 2016

Review session

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Example 1

C. Consider a 14 AWG (American Wire Gauge) copper wire which is typically used in residential applications. The diameter of 14 gauge wire is 1.62 mm. The conductivity for copper at room temperature is $5 \times 10^7\ (\Omega\ \text{m})^{-1}$.

You run the 14 gauge copper cable, 10 metres in length, from the electrical panel to an outlet.

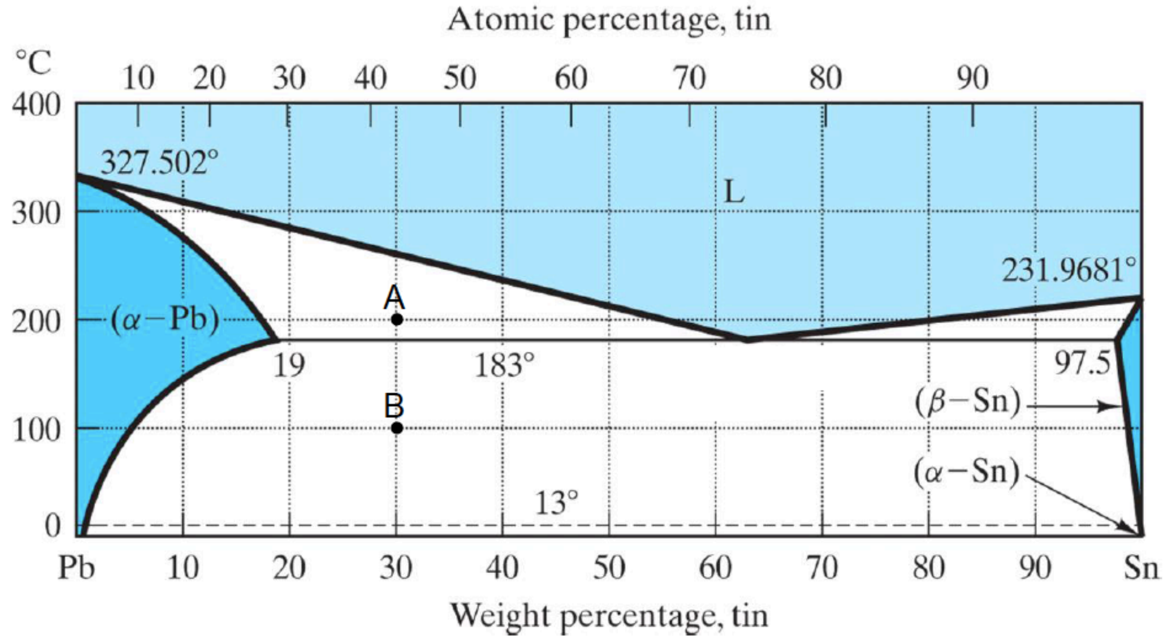
1. Calculate the resistance of the copper wire.

2. You connect an appliance to the outlet which draws 4 amperes of current. What is the voltage drop from the panel to the outlet due to the resistance of the copper wire?

3. If the voltage with respect to ground at the panel is 120 V, what is the voltage with respect to ground at the outlet?

Example 2

B) Based on the phase diagram below, answer the following questions. (7 marks)



i) The melting point of Sn is _____231.97 ºC_______.

ii) The eutectic temperature is ___183_ºC _ and the composition is __61.9 wt%Sn__.

iii) For point **A** on the phase diagram,

a. Determine the phase compositions

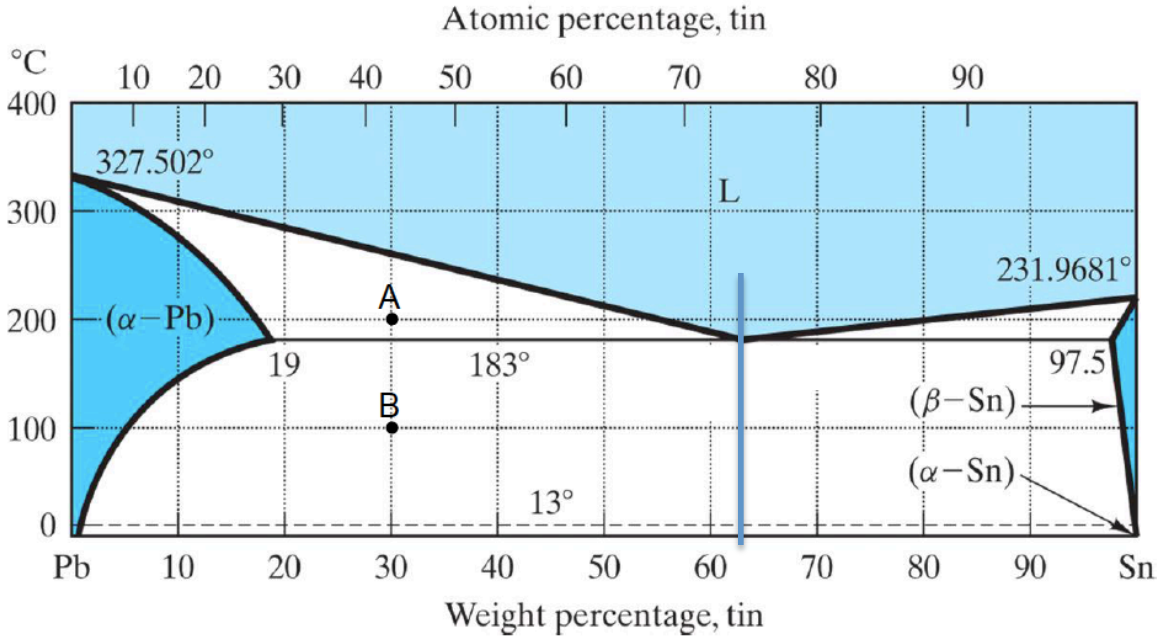
Tie line: $C\alpha$ = 18% Sn-82%Pb C_L = 55% Sn-45 %Pb

b. The relative fraction of each phase

$$w_\alpha = \frac{C_L - C_A}{C_L - C_\alpha} = \frac{55-30}{55-18} = 67.6\%$$

$$W_L = 1 - 0.676 = 32.4\%$$

B) **Based on the phase diagram below, answer the following questions. (7 marks)**



iv) For Point **B** on the phase diagram,

a. Determine the relative fraction of each phase in terms of α and the eutectic composition.

$C_{eutectic}$ = 61.9%Sn

$$w_\alpha = \frac{C_e - C_B}{C_e - C_\alpha} = \frac{61.9 - 30}{61.9 - 5} = 56.1\%$$

$$W_e = 1 - 0.561 = 43.9\%$$

b. What is the maximum solubility of Sn in Pb at this temperature?

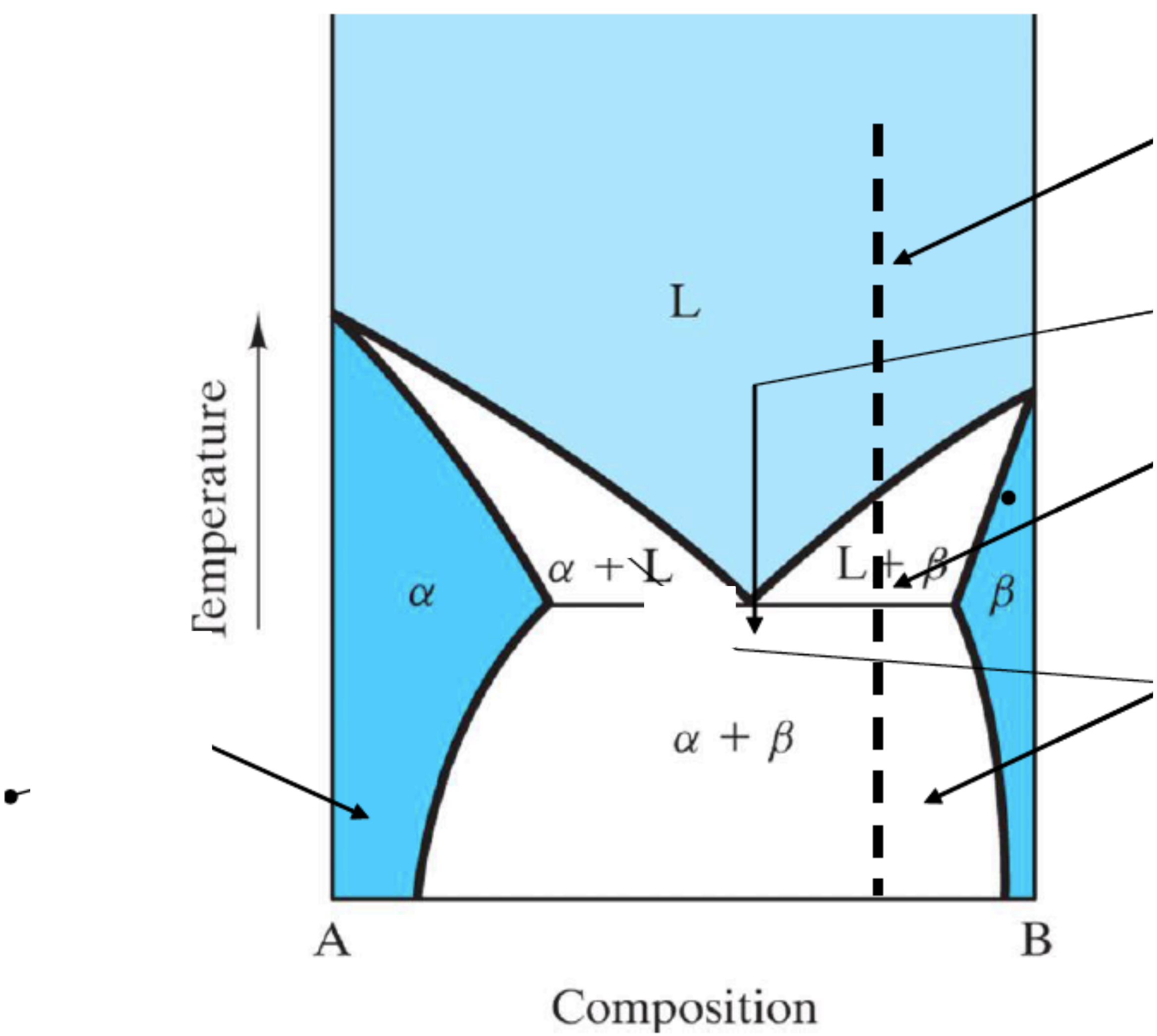
5%

C) In a hypothetical phase diagram, please complete the following: **(6 marks)**

i) Draw the corresponding structures in the squares

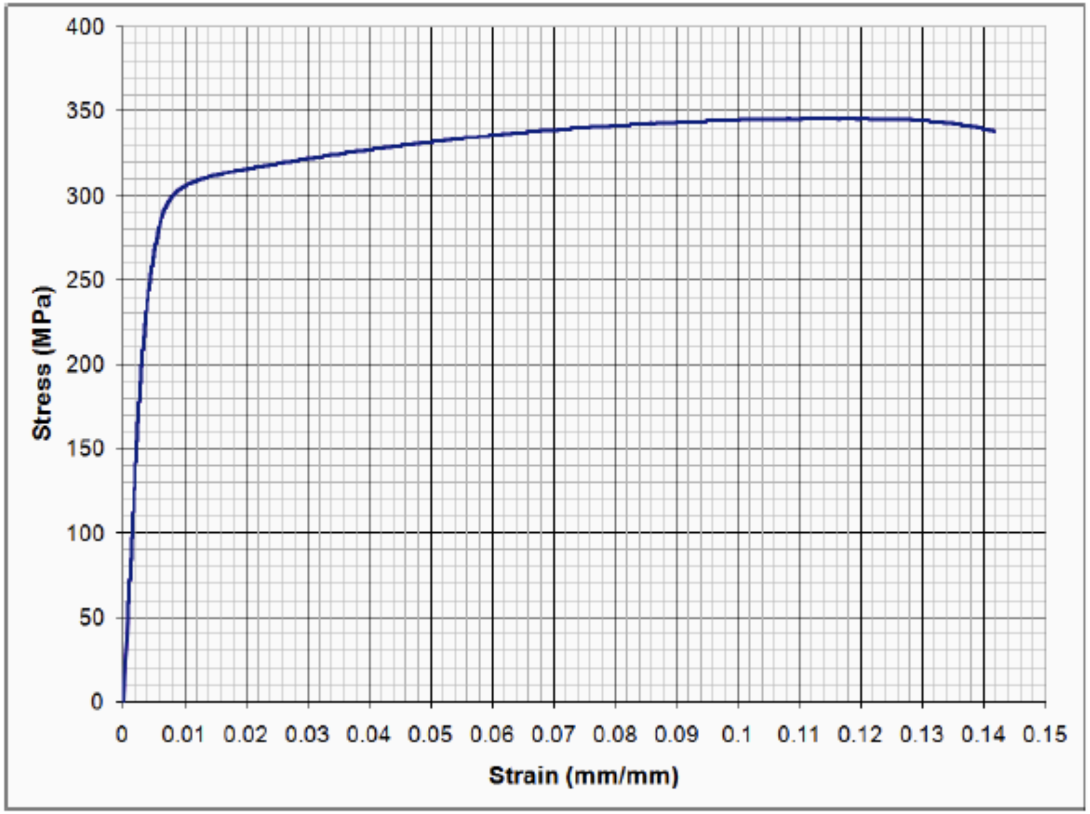
ii) Write the eutectic reaction and mark the eutectic point on the graph

L ←→ α + β



Example 3

5.1 Consider the stress-strain curve for aluminum shown below.



(a) Using the above stree-strain curve, find:numerical values for: **(6 marks)**

Young's Modulus	
Proportional Limit	
0.2% Yield Strength	
Tensile Strength	
Ductility	
Toughness	

Example 3

(b) Consider an aluminum bar with an initial diameter of 10 mm and an initial length of 100 mm which is progressively subjected to different load conditions. Determine numerical values of the length of the aluminum bar corresponding to the load conditions given below:

(i) Length when the tensile load is increased from 0 MPa to 150 MPa; (**1 mark**)

(ii) Length when the tensile load is further increased to 330 MPa; (**1 mark**)

(iii)Length when the tensile load is reduced to 0 MPa (from 330 MPa). (**2 marks**)

Example 4

Consider: $Br_2\,(l) \rightleftharpoons Br_2\,(g)$

At 1 bar pressure liquid bromine boils at 58.2°C, and at 9.3°C its vapour pressure is 0.1334 bar.

(a) Write the expression for K_P for the above reaction. **(1 mark)**

$$K_P = P_{Br2}$$

(b) Calculate $\Delta G°$ for the above reaction at 58.2°C and at 9.3°C. **(2 marks)**

$\Delta G°\ (331.35\ K) = -\ RT\ln K = -RT\ln 1 = 0$

$\Delta G°\ (282.45\ K) = -\ 8.3145 \times 282.45\ (J\ mol^{-1})\ \ln 0.1334 = 4730.7\ J\ mol^{-1}$

Example 4

(c) Assuming $\Delta S°$ and $\Delta H°$ to be temperature independent, calculate their values. **(3 marks)**

$$0 = \Delta H° - (331.35\ K)\ \Delta S°$$
$$4730.7\ J\ mol^{-1} = \Delta H° - (282.45\ K)\ \Delta S°$$

$\Delta H° = 32055\ J\ mol^{-1}$
$\Delta S° = 96.74\ J\ K^{-1} mol^{-1}$

(d) Calculate the vapour pressure and $\Delta G°$ at 25°C. **(3 marks)**

$\Delta G° = 32055\ J\ mol^{-1} - (298.15K)(\ 96.74\ J\ K^{-1} mol^{-1}) = 3212\ J\ mol^{-1}$
$P = K_P = \exp\ (-3212/8.3145 \times 298.15) = 0.274$ bar

Example 5

1.5 moles of a diatomic ideal gas undergoes the following reversible cyclical process from an initial state characterized by T = 275 K and P = 1 bar:

- Adiabatic expansion until volume is tripled
- Heating at constant volume until T increases to 275 K
- The pressure is increased in an isothermal reversible process until P = 1 bar.

a) Sketch a pressure- volume diagram representing this cycle.
b) Calculate q, w, ΔU, ΔH, and ΔS for each step and for the total cycle.