EXAM / 2 hours

Exercise 01 : (06pts)

1. The liquid-solid transformation of a pure substance occurs at varying temperatures. (Answer the following questions with True or False. Justify your answer.)

2. Give the general form of the following reactions (transformations) : Monotectic, Eutectoid and Peritectic.

3. Define the term, Diffusion.

4. Give the different mechanism of diffusion.

5. Write the first law of Fick for one dimension for an isotropic medium

6. Write the first law of Fick for three dimensions

Exercise 02 : (07 pts)

Consider the phase diagram of Mg-Ni (**Figure 1**):

1) On the diagram, fill in the empty areas with phases.

2) Indicate the liquidus and solidus lines on the diagram using different colors.

3) What are the melting points of Mg and Ni?

4) Give the different reactions (phase transformations) that exist. Specify the coordinates (mole fraction of Ni, T) of each reaction.

5) What is the name of the plateau located at 759°C?

6) Determine the percentage of phases for the 0.2% Ni alloy (or 20% Ni) at T = 450°C.

Exercise 03 : (07 pts)

Figure 2 represents the Fe-C diagram as shown below:

1) Give the melting point of Fe.

2) Give the phases present in regions 1, 2, and 3.

3) What does point R1 represent?

4) What does point R2 represent?

Consider the following Ag-Cu diagram (**Figure 3**):

1. Plot the cooling curves for the following alloys: 20%, 55%, and 100% Pt.

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Nom et prénom : ……

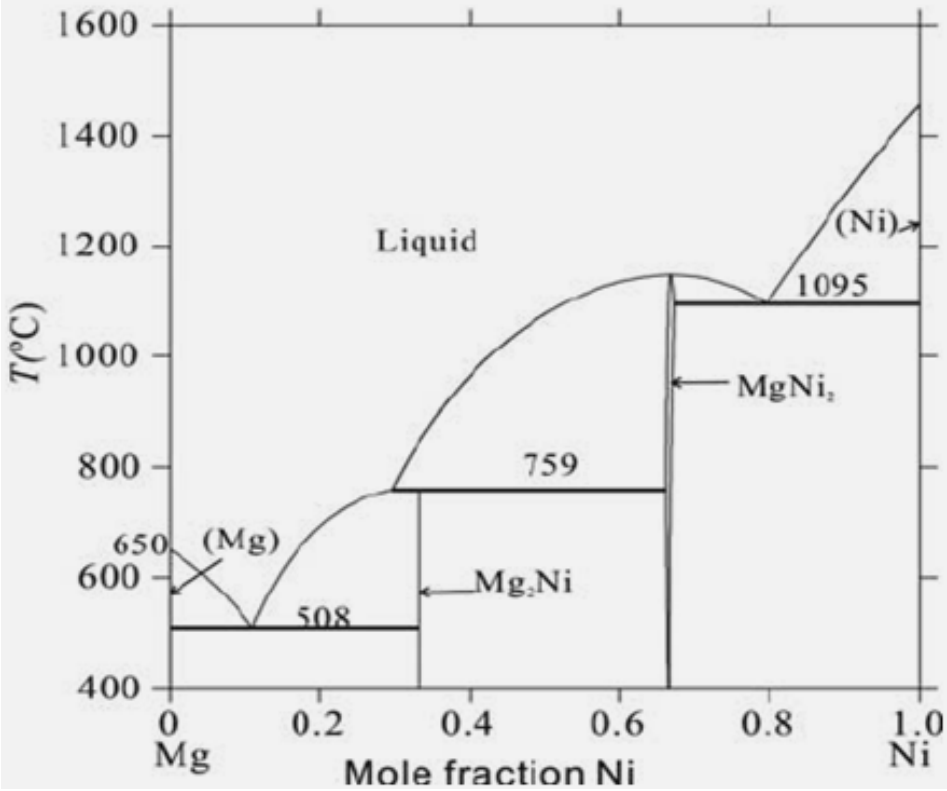

Figure 1

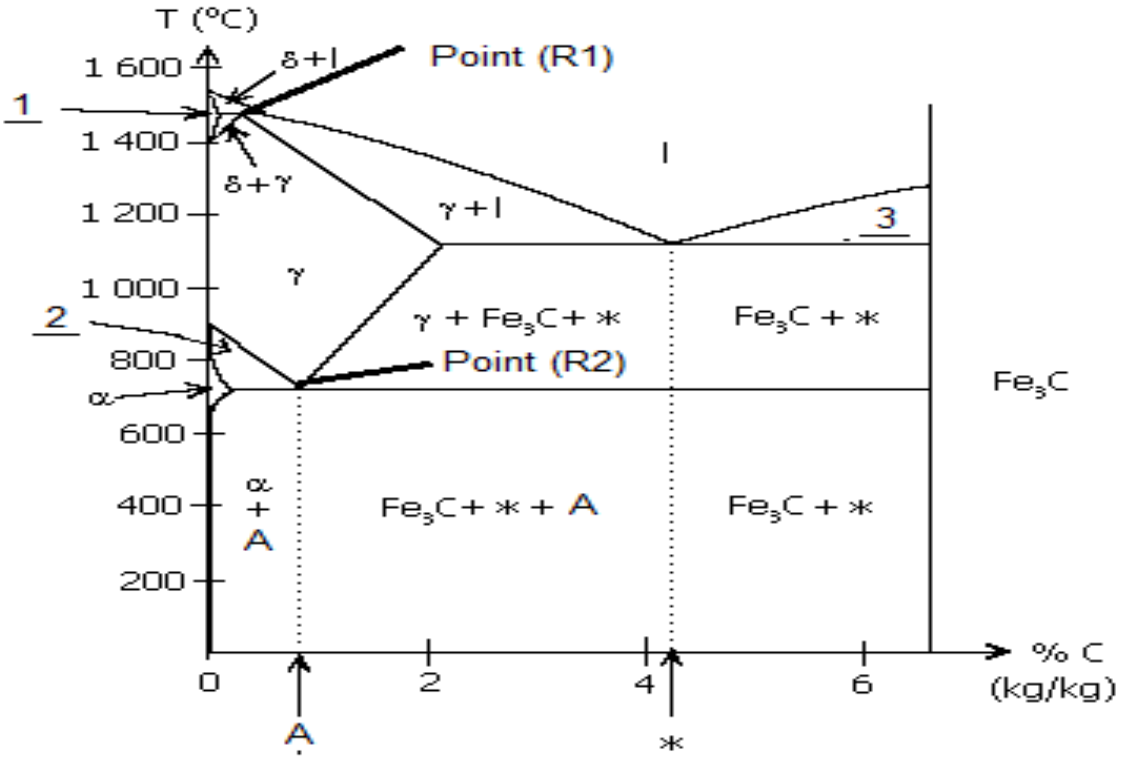

Figure 2

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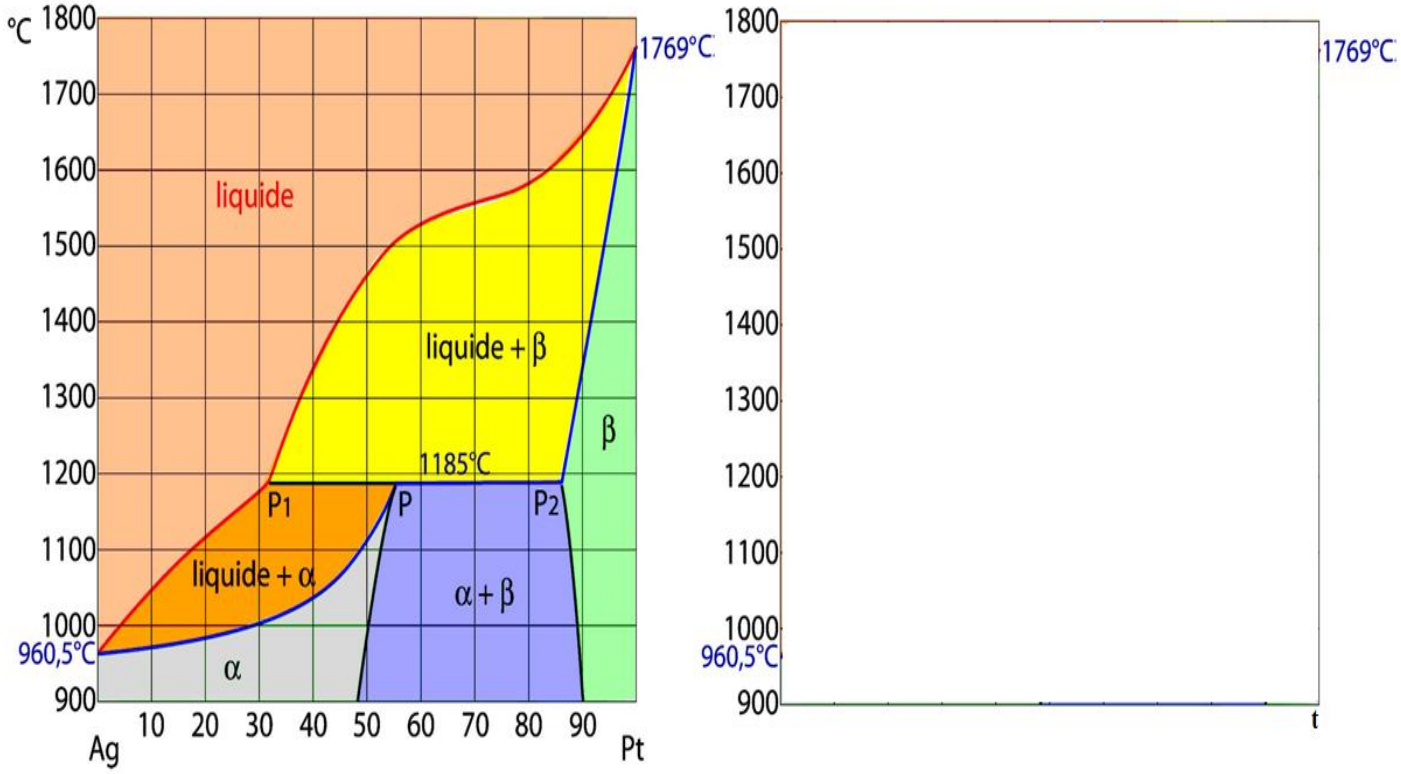

°C
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
960,5°C
1769°C
liquide
liquide + β
β
1185°C
P1
P
P2
liquide + α
α + β
α
10 20 30 40 50 60 70 80 90
Ag
Pt
t

Figure 3

Exercice 01 :

1. No, the liquid-solid transformation of a pure substance occurs at constant temperature **(0.5 pt)**

2. (0.5*3 = 1.5 pt)

Monotectic: L1 --→ L2 + α (Liquid 1 becomes Liquid 2 + solid).

Eutectoid: γ --→ β + α (Solid becomes 2 solid).

Peritectic: L + α --→ γ (Liquid + solid becomes solid).

3. Diffusion is the transport of matter from one point to another by thermal motion of atoms or molecules. **(0.5 pt)**

4. Different mechanism of diffusion are : **(0.25*5 = 1.25 pt)**

* Interstitial Mechanism, * Direct exchange mechanism, * Ring mechanism, * Vacancy mechanism, * Interstitial-substitutional exchange mechanism, *

5. (0.5 pt)

Fick's first law for an isotropic medium can be written as: $J_x = -D\frac{\partial C}{\partial x}$

6. (0.75 pt)

Fick's first law for three dimensions: $J = -D \nabla C$

<u>Exercice02: (7.5 pts)</u>

1) Sur le diagramme, remplir les domaines vides en phases. **(0.25*6= 1.5pt)**
2) Les lignes liquidus et solidus (voir diagramme). **(1.5 pt)**
3) Les températures de fusion de l'élément Mg et Ni sont en respectivement 650°C et 1455°C. **(1 pt)**
4) Les différentes réactions (transformations de phases) existantes :

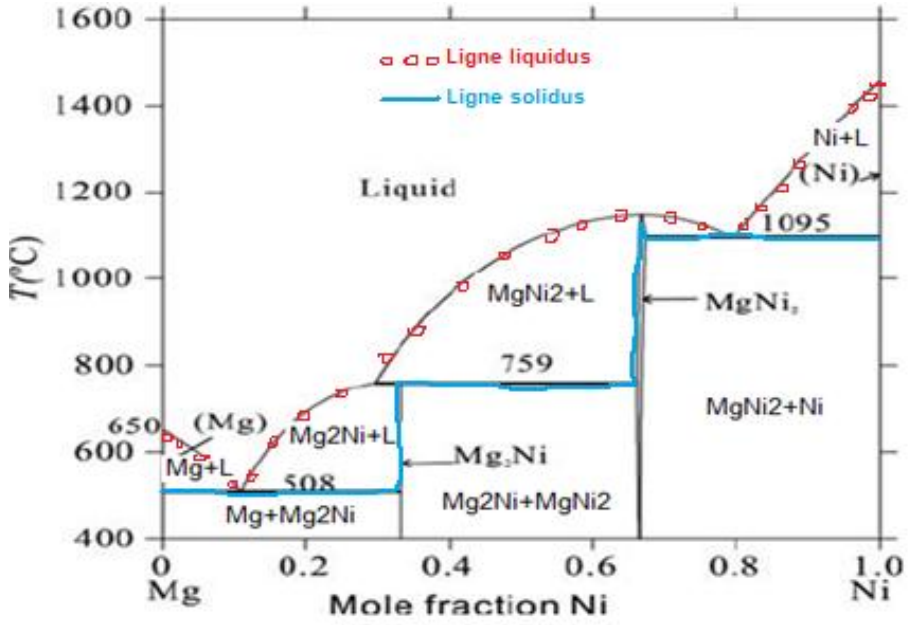
- Transformation Eutectique, L ⟶ Mg +Mg_2Ni, (0.1, 508°C) **(0.5 pt)**
- Transformation Péritectique, L + $MgNi_2$ ⟶ Mg_2Ni, (0.35, 759°C) **(0.5 pt)**
- Transformation Eutectique, L ⟶ Ni + $MgNi_2$, (0.8, 1095°C) **(0.5 pt)**

Le palier situé à 759°C s'appelle palier Péritectique. **(0.5 pt)**

5) Pourcentage de phases pour l'alliage 0.2%Ni et à T= 450°C :

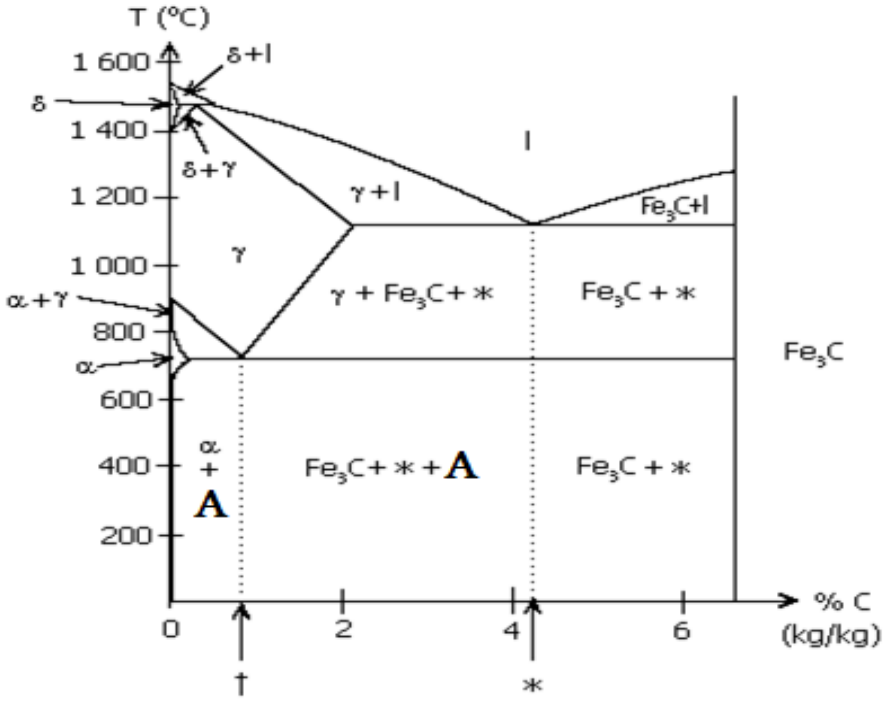
Mg%= (0.35-0.2)/(0.35-0)= 0.42 = 42% **(0.5 pt)**

$Mg_2Ni\%= (0.2-0)/(0.35-0)= 0.58 = 58\%$ **(0.5 pt)**



Exercice 03 : (7 pts)

1) Température de fusion de Fe est 1538°C ***(0.75 pt)***
2) Les phases existantes aux domaines :
- 1 : δ (Ferrite delta) ***(0.75 pt)***
- 2 : $\alpha + \gamma$ ***(0.75 pt)***
- 3 : L+ Fe_3C. ***(0.75 pt)***
2) R1 est le point Péritectique, ***(0.75 pt)***
3) R2 est le point Eutectoide. ***(0.75 pt)***



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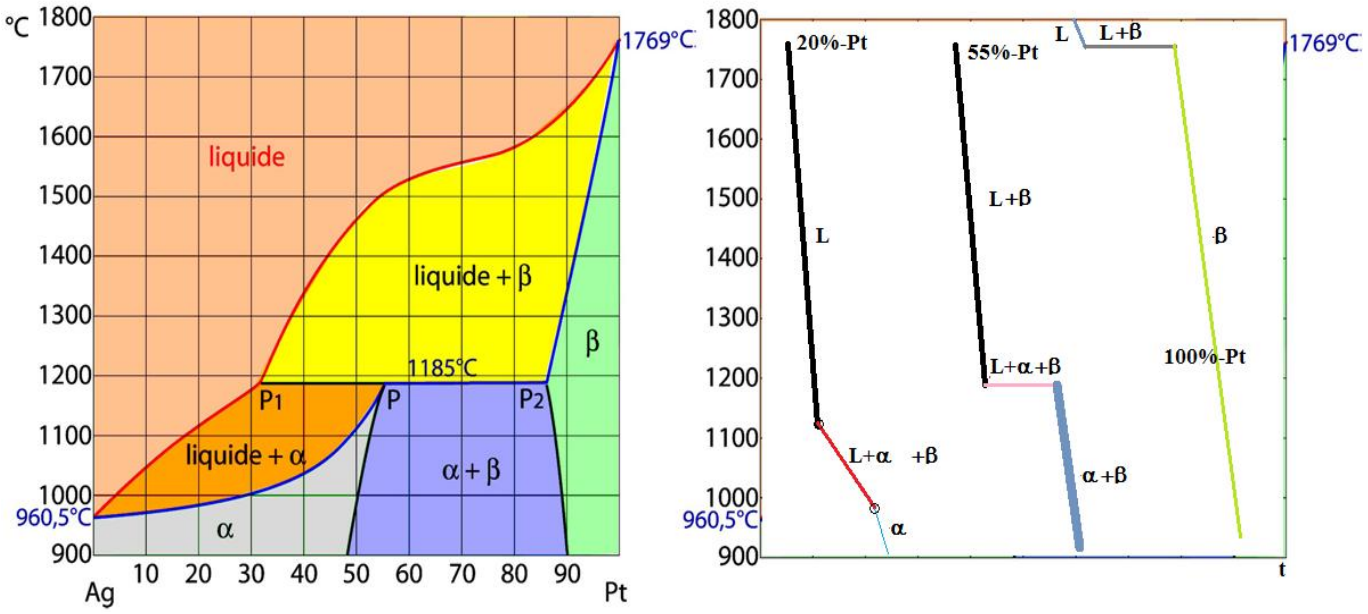
The cooling curve (0.5*3 = 1.5pt)



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