

答題要領：

- (1) 請按題号順序回答
- (2) 答題語文僅限中文、英文及日文。

請設法簡明的說明下列問題：

1) 說明垂共晶組成合金之凝固過程：

- a) 凝固曲線特徵
- b) 組織形成過程及形態
- c) 成分固定時、請列舉能影響機械性質的組織学要因

(本題 10 分)

2) 軟鋼在經過種種不同塑性加工及熱處理之後，設肥粒鉄平均粒徑自 $50 \mu\text{m}$ 變化至 $20 \mu\text{m}$ ，請定量的計算降伏點強度變化量 (Hall-Petch 之關係係數為 $k = 2.5 \text{ kgf/mm}^{-3/2}$)

(本題 10 分)

3) 請用核生成及核成長的觀點說明下列現象之理由

- a) Martensite 在安定相之體心立方鋼試料與 Fe_3C 上不生成，但却在過飽和之面心立方鋼試料上生成，為何？
- b) 低溫回火加熱處理時不析出 Fe_3C ，但却析出 ϵ -Carbide，為何？

(本題 a, b 各 10 分)

4) 有多數的合金 (例如 Fe-Mn-Al 合金) 有下述現象存在，請具體說明理由：

- 實施高溫退火處理後、鑄造試料無退火雙晶 (annealing twin) 出現而壓延試料却有多數的退火雙晶出現 (參考下圖)，為何？

(本題 10 分)



(5.) The diffusion rate of carbon in α iron (ferrite)

佔 10 分

and γ iron (austenite) are given by

$$D_{\alpha} = 0.0079 \text{ cm}^2/\text{sec} e^{(-18,100 \text{ cal/mole})/RT}$$

$$D_{\gamma} = 0.21 \text{ cm}^2/\text{sec} e^{(-33,800 \text{ cal/mole})/RT}$$

$$R = 1.987 \text{ cal/degree-mole}$$

- Calculate the two diffusion coefficients at 800°C and at 1000°C
- Explain the magnitude of D_{α} compared to D_{γ} in terms of atomic structure
- Draw a composition-distance plot of a carbon-iron diffusion couple heat-treated at 800°C . (see iron-carbon phase diagram as below)
- Why are commercial carburizing treatments of steel carried out when the steel is austenitic?

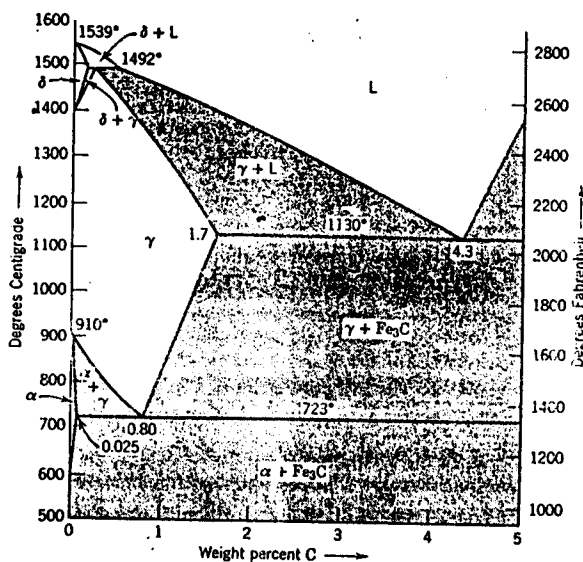
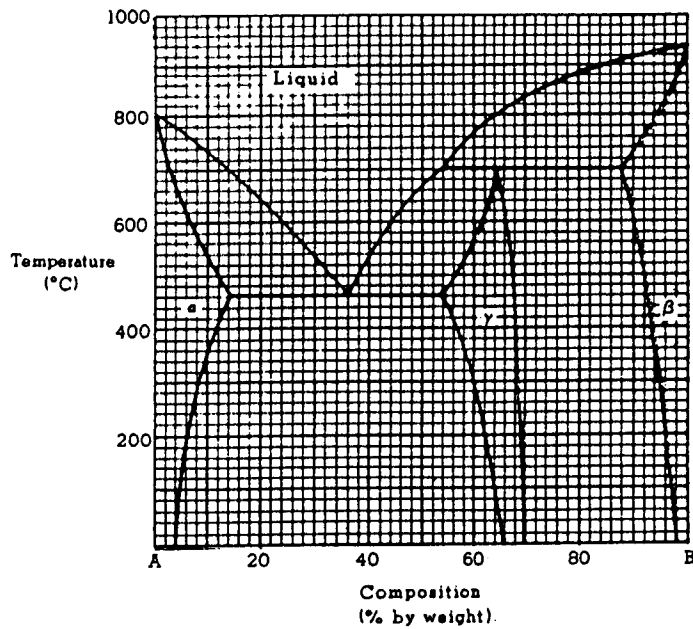


Figure . The phase diagram for metastable Fe-Fe₃C.

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Questions 1-10 relate to the phase diagram shown below. A and B are pure elements and α , β , γ are solid solutions. Assume equilibrium conditions unless otherwise specified. All temperatures are in degrees centigrade and all compositions are in per cent by weight. 單選。請將計算式子列入答案卷上。



1. Which of the following is the name of the isothermal reaction taking place at 700°C ?
(A) Peritectic (B) Eutectic (C) Syntectic
(D) Peritectoid (E) Eutectoid
2. The maximum solubility of A in B in per cent by weight is most nearly
(A) 2% (B) 4% (C) 12% (D) 14% (E) 36%
3. The amount of γ contained in a 120-kilogram alloy of 54 per cent by weight B at 600°C is most nearly
(A) 14.1 kg. (B) 41.2 kg. (C) 49.4 kg.
(D) 58.8 kg. (E) 70.6 kg.
4. If an alloy of 10 per cent by weight B is cooled from 440°C under nonequilibrium conditions, which of the following conditions will be present in the alloy?
(A) Liquid immiscibility
(B) Supersaturation
(C) Pearlite formation
(D) Martensitic transformation
(E) Liquation at grain boundaries

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5. For an alloy of 70 per cent by weight A, the percentage of phases present at 250°C are most nearly

- (A) 25.0% α and 75.0% β
- (B) 42.3% α and 57.7% γ
- (C) 57.7% α and 42.3% γ
- (D) 7.2% β and 92.8% γ
- (E) 92.8% β and 7.2% γ

6. The compositions of the phases present in an alloy of 80 per cent by weight B at 600°C are most nearly

- (A) $\alpha = 7\%$ B and $\beta = 90\%$ B
- (B) $\alpha = 7\%$ B and $\gamma = 23\%$ B
- (C) $\beta = 60\%$ B and $\gamma = 40\%$ B
- (D) $\beta = 90\%$ B and $\gamma = 61\%$ B
- (E) $\beta = 90\%$ B and $\gamma = 65\%$ B

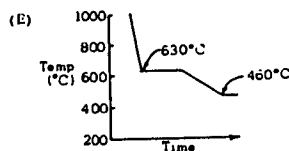
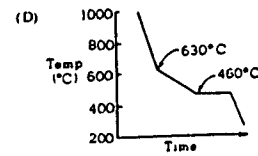
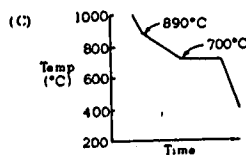
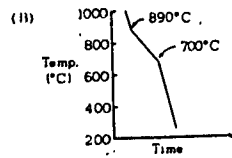
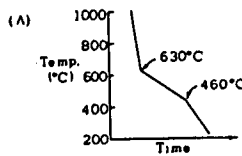
7. If one assumes that pressure is constant at 1 atmosphere, what are the number of degrees of freedom for a system with a composition of 45 per cent by weight B at 720°C?

- (A) 0 (B) 1 (C) 2 (D) 3 (E) 4

8. If one assumes that A and B are ceramic oxides, the highest safe temperature at which a refractory brick made from 70 per cent by weight B could be used is most nearly

- (A) 440°C (B) 680°C (C) 780°C
- (D) 920°C (E) 1000°C

9. Which of the following graphs best represents a cooling curve for an alloy of 20 per cent by weight B that is cooled from the liquid?



10. If the density of A is 2.25 grams per cubic centimeter and that of γ is 2.70 grams per cubic centimeter, the volume percentages of phases present for a 40 per cent by weight of B alloy at 100°C are most nearly

- (A) 6.1% α and 93.9% γ
- (B) 35.4% α and 64.6% γ
- (C) 39.7% α and 60.3% γ
- (D) 44.1% α and 55.9% γ
- (E) 60.3% α and 39.7% γ

(7) 請比較一般析出 (precipitation) 和離相分解 (spinodal decomposition 或叫作節點分解) 之不同。說明請以簡要為原則。
佔5分

(8) 請由原子排列和鍵接的觀點簡答下列問題：
佔10分

(a) 為何一般金屬材料比陶瓷材料之"延展性"高？

(b) 溫度對於一般金屬材料和陶瓷材料"導電"性質的影響分別為何？

(c) 溫度對於一般金屬材料和陶瓷材料"導熱"性質的影響分別為何？

(9) 請簡要地解釋下列各名詞
佔15分

(a) Anisotropy

(b) Bragg Law

(c) Born theory of ionic crystals

(d) Miscibility Gap (可用簡圖說明)

(e) Critical Stress Intensity Factor