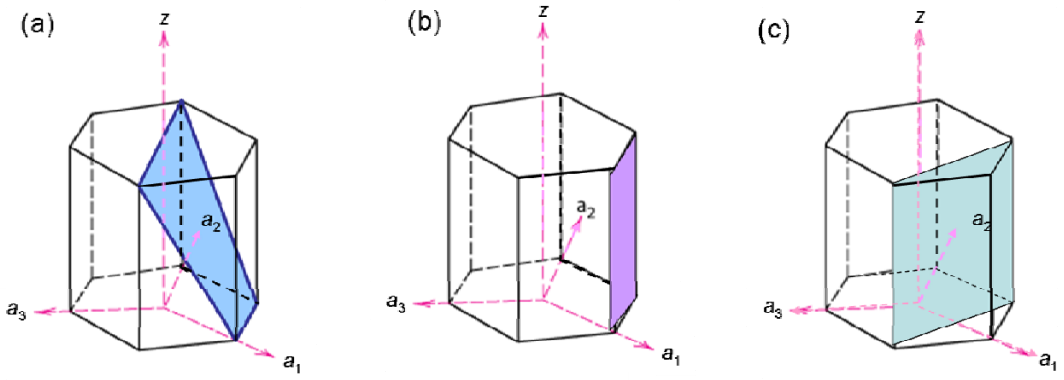
國立高雄大學 101 學年度研究所碩士班招生考試試題

科目：材料科學導論
考試時間：100 分鐘

系所：化學工程及材料工程學系
（乙組）
本科原始成績：100 分

是否使用計算機：是

1. Determine the indices for the planes shown in the hexagonal unit cells below: (5%)



2. Zinc's crystal structure is HCP with the ratio of lattice parameters c/a=1.856. If the radius of the Zinc atom is 0.135 nm, calculate the (a) Atomic Packing Factor (b) density of Zinc (g/cm^3). (10 %) (Hint: atomic mass of Zn is 65.39 amu)

3. Calculate the equilibrium number of vacancies per cubic meter for copper at 1200℃. The energy for vacancy formation is 0.9 eV/ atom; the atomic weight and density (at 1000℃) for copper are 63.5 g/mol and 8.4 g/cm^3, respectively. (Boltzmann's constant k= 8.62× 10^{-5} eV/atom) (10%)

4. A crystal's ideal shape in thermodynamic condition is generally related to their surface energy of each crystallographic plane. (a) Please explain the relations as possible as you can. (b) Besides, what factors may influence surface energy? (10%)

5. An FCC iron-carbon alloy initially containing 0.20 wt% C is carburized at 1027℃ and in an atmosphere that gives a surface carbon concentration constant at 1.0 wt%. After 49.5 h the concentration of carbon is 0.35 wt% at a position 4.0 mm below the surface. (15%)

(a) Does the diffusion behavior follow Fick's first law or second law? Why?

(b) Calculate the diffusion coefficient of carbon in the alloy.

(c) Calculate the carbon concentration at position 1, 2, 3 mm below the surface, respectively, and sketch a carbon concentration vs. depth plot in the depth range of 1~4 mm

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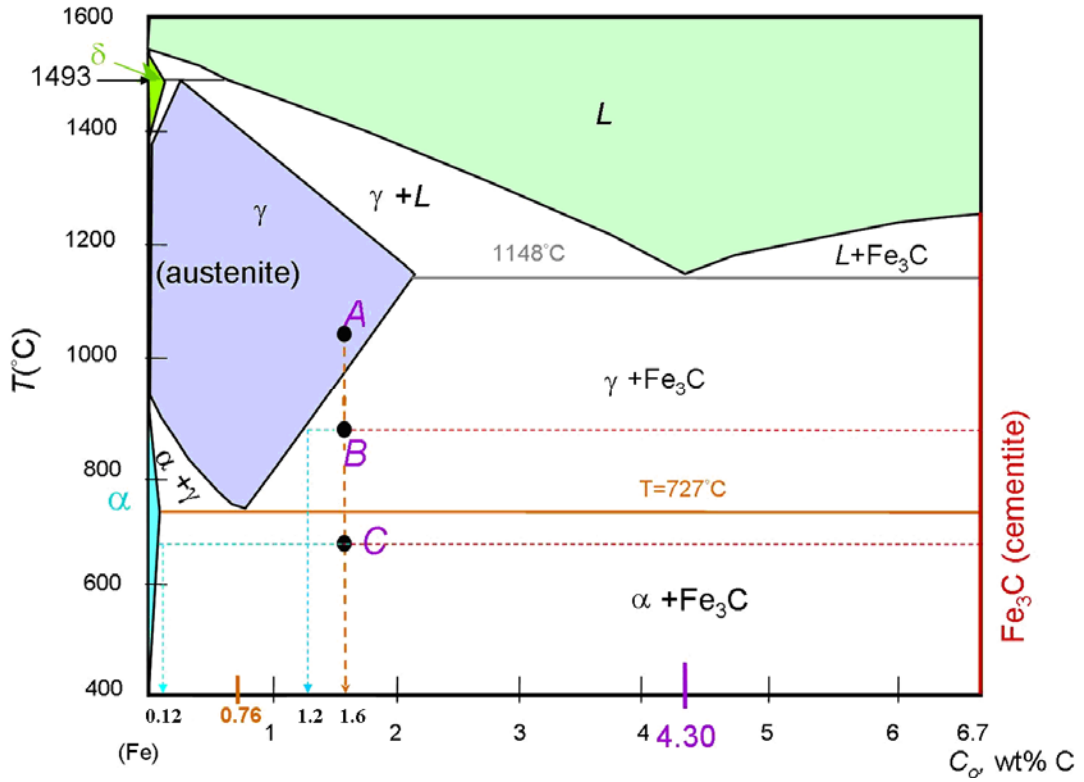
z	*erf*(*z*)	*z*	*erf*(*z*)	*z*	*erf*(*z*)
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9523
0.05	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	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

6. Steel is a very important alloy in industry and the figure below is the phase diagram of Fe-Fe_3C (15%)

(1) Write down the eutectic, eutectoid, peritectic reactions of the system, including the specific temperatures and compositions

(2) an alloy containing 1.6wt% C is equilibrium cooled from A to B and C point, as shown in the figure, (a) sketch the microstructures (b) estimate the composition of each phases (c) calculate the weight fraction of each phases of the alloy in A, B, and C conditions



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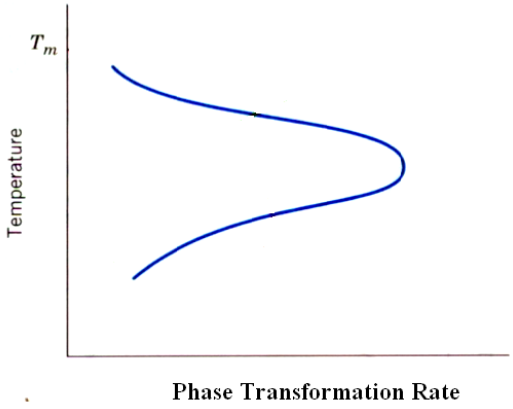
7. The figure below shows the phase transformation rate as a function of temperature. Please explain why there is an optimized temperature for phase transformation rate. (5 %)



8. N- and p-type semiconductors are critical materials for fabricating p-n diodes. Please propose some methods to distinguish p- or n- type carrier transport of an unknown semiconductor. Explain related physical theories and meanings involved. (10%)

9. Translate the English abstract below to Chinese: (英翻中) (5%)

Superplastic carbon nanotubes

The theoretical maximum tensile strain—that is, elongation—of a single-walled carbon nanotube is almost 20%, but in practice only 6% is achieved. Here we show that, at high temperatures, individual single-walled carbon nanotubes can undergo superplastic deformation, becoming nearly 280% longer and 15 times narrower before breaking. This superplastic deformation is the result of the nucleation and motion of kinks in the structure, and could prove useful in helping to strengthen and toughen ceramics and other nanocomposites at high temperatures. (*Ref: Nature **439**, 281 (19 January 2006))*

10 .能源危機是舉世關心的話題，材料科學在再生能源的研發扮演重要的角色。請選擇下列兩種重要的再生能源 (a) 太陽能電池 (b) 熱電材料發電 的其中一種，解釋其材料或元件發電之原理，並說明材料設計的觀念以達到高的轉換效率 (5 %)

11. A customer sent a sample for you to characterize. The sample was coated with a layer of thin film with thickness of around 100 nm. Please propose some methods to characterize the structures and compositions of the film as possible as you can. Describe the principles of the equipments used and what information of the sample may be obtained. (10%) (材料分析，盡所能申論之!)