

1. Calculate the planar density and planar packing fraction for the (010) and (020) planes in simple cubic polonium. (Lattice parameter for Po = 3.34 Å.) (5%)
2. A 1050 steel is isothermally heat treated to give a Rockwell hardness of 23. Based on the diagrams shown in Figure 1, describe the heat treatment and the amount of each micro-constituent after each step of heat treatment. (10%)

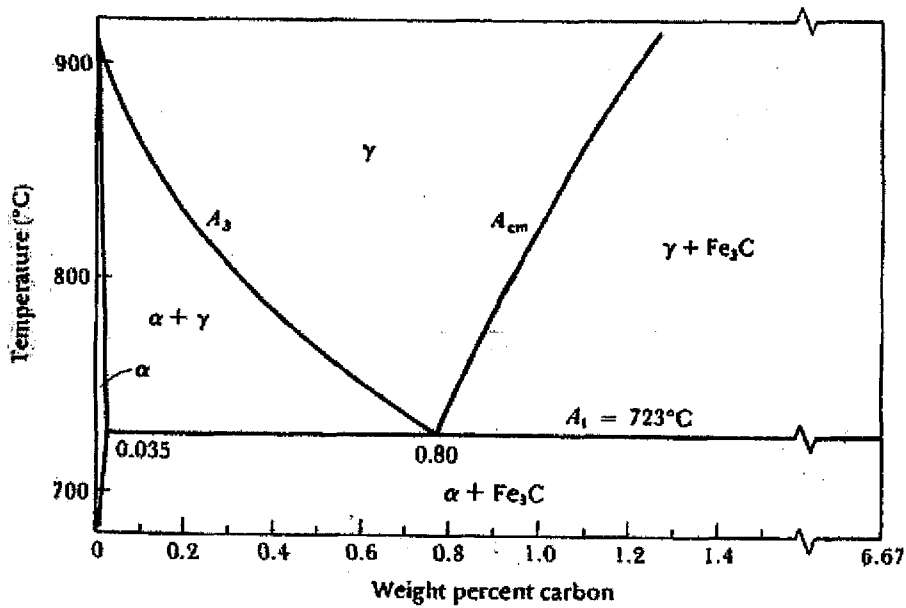


Figure 1(a) The eutectoid portion of the Fe-Fe₃C phase diagram.

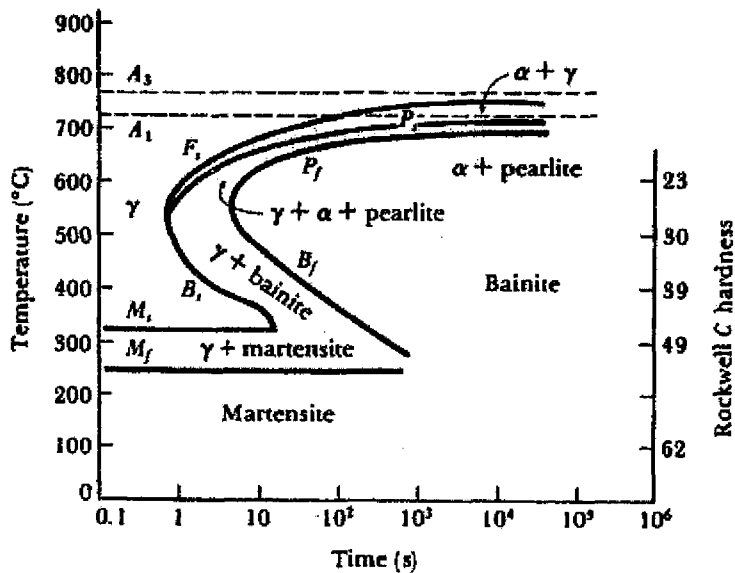


Figure 1(b)
The TTT diagram
for a 1050 steel.

3. Calculate the change in volume (i.e. in percentage) that occurs when BCC iron is heated and changes to FCC iron. At the transformation temperature, the lattice parameters of BCC and FCC irons are 2.863 Å and 3.591 Å, respectively. (5%)
4. Portion of the magnesium-aluminum phase diagram is shown in Figure 2. Suppose a Mg(8%)–Al alloy is responsive to an age-hardening heat treatment. Recommend a heat treatment procedure for this alloy. (10 %)

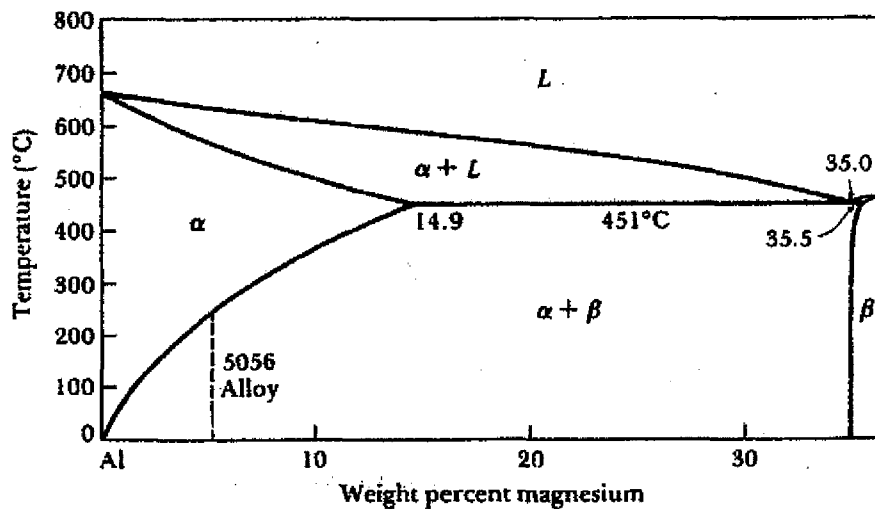


Figure 2 Portion of the phase diagram for Al-Mg.

5. CaTiO_3 has a perovskite structure. Does the Ti^{4+} ion in the center of the cell rattle (鬆動) around in its interstitial site? Show calculations to justify your answer. (The ionic radii for Ca^{2+} , Ti^{4+} , and O^{2-} are 0.99Å, 0.68Å, and 1.32Å, respectively.) (5%)
6. Determine the type of structure for the following two silicate minerals:
 $\text{CaO} \cdot \text{MnO} \cdot 2\text{SiO}_2$ and $\text{Na}_2\text{O} \cdot 2\text{SiO}_2$ (5%)
7. What is the Weibull modulus and why is it important in designing with brittle materials? (5%)
8. Why the maximum service temperature of a SiO_2 - Al_2O_3 fireclay refractory brick can be increased by upgrading the alumina content? (5%)

國立臺灣大學九十四學年度轉學生入學考試試題

科目：材料科學導論

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9. Please define glass transition temperature of polymer. Explain why the glass transition temperature of polypropylene $-(CH_2CH(CH_3))_n-$ ($-18^\circ C$) is higher than the glass transition temperature of polyethylene $-(CH_2CH_2)_n-$ ($-110^\circ C$). (5%)
10. Please compare the differences between linear polymer and branched polymer (assume: they have similar molecular weight) in terms of tensile strength, glass transition temperature, crystallinity and their solution viscosity when they are dissolved in good solvent. (10%)
11. The conductivity of the semiconductor has a value of $3 \times 10^{-4} (\text{Ohm}\cdot\text{m})^{-1}$ at $20^\circ C$ and $160 (\text{Ohm}\cdot\text{m})^{-1}$ at $200^\circ C$. Please calculate the bandgap of this material. Explain why the conductivity increases while the temperature increases for semiconductor. Do you see the same trend for metal? Explain. (15%)
12. Please define a diode. Do all diodes emit light? What is the principle of light emitting from the diode? (5%)
13. The acronym MOSFET stands for Metal-Oxide-Semiconductor Field Effect Transistor. Please draw a sketch for a MOSFET device and explain the significance of each of these terms as applied to the device. (5%)
14. Please define copolymer and polymer blend. How would you distinguish them from each other? Please use three different methods to tell them apart. Explain your answers. (10%)