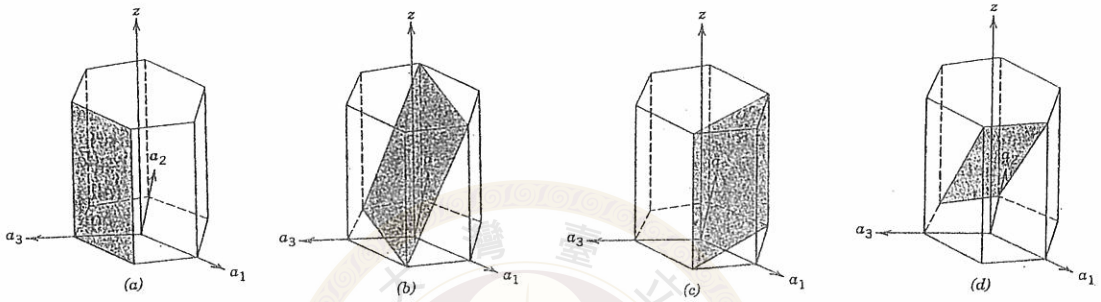
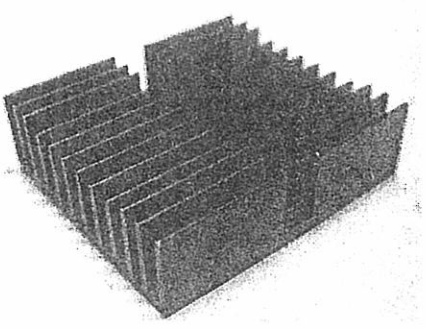
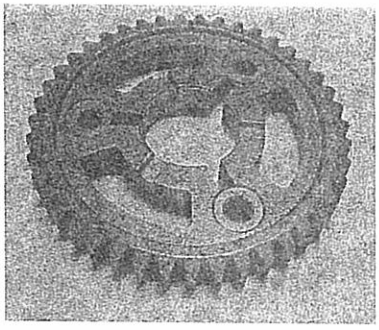
1. Consider the defects in crystals in the following questions.
   (a) How to distinguish edge dislocation from screw dislocation via the relative orientations of dislocation line and Burgers vector? (5%)
   (b) Give five examples for two-dimensional defects in crystals. (5%)
   (c) Give two reasons why interstitial diffusion is normally more rapid than vacancy diffusion. (2%)
2. Determine the indices for the planes shown in the hexagonal unit cells below: (8%)



3. Draw the typical microstructure of the following materials:
   (a) Furnace cooled Fe-0.85C steel. (b) As-cast Fe-3.6C-2.3Si-0.06Mg-0.1Ni-0.05Mo. (4%)
4. Does the surface-carburized Fe-0.2C have a higher fatigue strength than the normalized Fe-0.4C? Why (You must explain to support your answer)? (4%)
5. You are asked to make the parts shown below. What is the manufacturing process you choose for making (a) aluminum cooling fins and (b) steel gears, respectively? You must explain why you choose that process. (4%)



(a)



(b)

6. Draw a sketch to show the unit cell (include the positions of the atoms) of the martensite of a steel. (4%)

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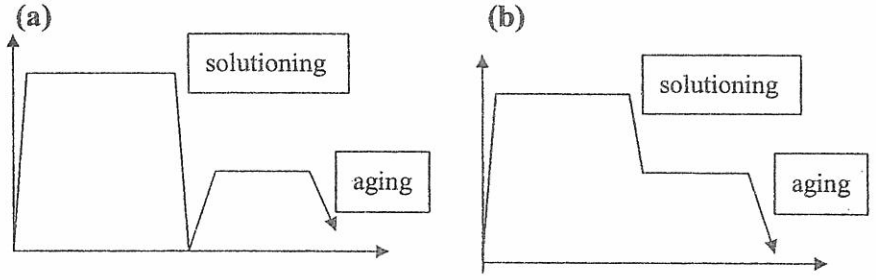
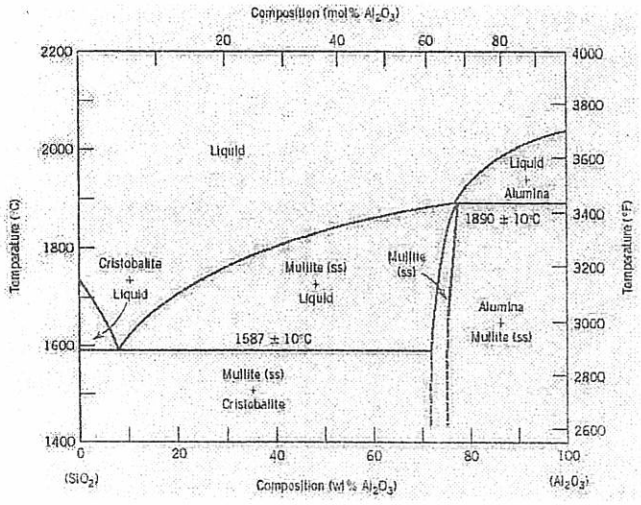
7. Figure a below is an optimized solutioning and aging process for Al-4Cu. Will the hardness increase or decrease when another process, as shown in Figure b, is used? Why (You must explain to support your answer)? Is there any advantage by using process "b"? (Figure b has the same solutioning and aging temperature and time as those in Figure a.) (4%)



8. How does the electron structure of an isolated atom differ from that of a solid material? (10 %)
9. Briefly describe the origins of the magnetic moment of an atom. Do all atoms have a net magnetic moment? Why or why not? (10 %)
10. (a) What is the glass transition temperature? (5%)
    (b) Why is the glass transition temperature of rubber always lower than room temperature? (5%)
    (c) Cite two different experimental methods to determine the glass transition temperature of polymer. (5%)
11. Sketch cis and trans structures for polybutadiene. (5%)
12. By using the phase diagram as following, for each pair of the following list of composition, which would you judge to be the more desirable refractory? Explain briefly. (10%)
    (a) 10 wt% Al_2O_3-90wt% SiO_2 and 20 wt% Al_2O_3-80wt% SiO_2
    (b) 70 wt% Al_2O_3-30wt% SiO_2 and 80 wt% Al_2O_3-20wt% SiO_2



13. Some of modern kitchen cookware is made of ceramic materials. For example, zirconia is used as the material for kitchen knife. List two important characteristics required of a material to be used for this application. (10%)

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