1. In the cubic system, which of the (110) family of direction represents the line of the intersection between the (111) and $(11\bar{1})$ planes. (5 分)
2. Determine the indices for the planes shown in Figure 1a and 1b. (10 分)

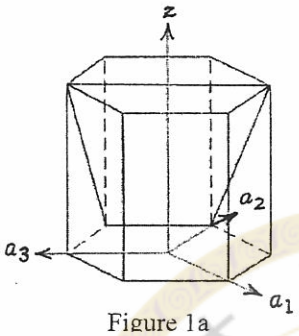

Figure 1a

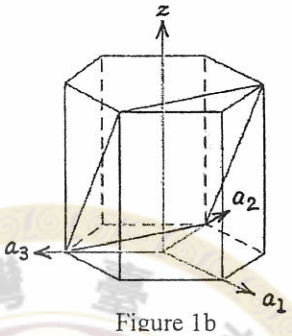

Figure 1b

3. Compare and contrast edge and screw dislocations. (5 分)
4. For a steel alloy it has been determined that a carburizing heat treatment of 10-h duration will raise the carbon concentration to 0.45 wt% at a point 5 mm from the surface. Estimate the time necessary to achieve the same concentration at a 2.5-mm position for an identical steel at the same carburizing temperature. (5 分)
5. Is it possible for two screw dislocations of opposite sign to annihilate each other? Explain your answer. (5 分)
6. Cite three metallurgical/processing techniques that are employed to enhance the creep resistance of metal alloys. (5 分)
7. On the basis of diffusion considerations, explain why fine pearlite forms for the moderate cooling of austenite through the eutectoid temperature, whereas coarse pearlite is the product for slow cooling rates. (5 分)
8. If electroneutrality is to be preserved, what point defects are possible in NaCl when a Ca^{2+} substitutes a Na^{+} ion? How many of these defects exist for every Ca^{2+} ion? (10 分)
9. From a molecular perspective, briefly explain the mechanism by which clay minerals become hydroplastic when water is added. (5 分)

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10. Figure 2 is the magnesium-lead phase diagram

(1) Identify all the invariant and congruent points on the Mg-Pb binary phase diagram. List them by composition, temperature of reaction, type of reaction, and the phase changes that occur on cooling through the reaction temperature. (10 分)

(2) Describe the equilibrium cooling process and likely microstructure for an alloy of Mg-20wt%Pb. (5 分)

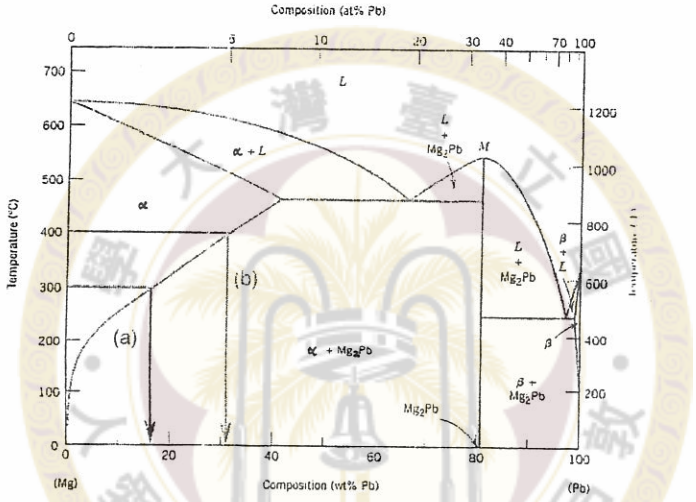

Figure 2

11. Explain briefly why the tendency of a polymer to crystallize decreases with increasing molecular weight. (5 分)

12. Contrast the manner in which stress relaxation and viscoelastic creep tests are conducted. (5 分)

13. Explain why no free electron is generated by the electron excitation involving an acceptor impurity atom. (5 分)

14. Cite the differences in operation and application for junction transistors and MOSFETs. (5 分)

15. Briefly explain why cold-worked metals are more susceptible to corrosion than noncold-woked metals. (5 分)

16. Will the electrical conductivity of the nonocrystalline metal be greater or less than its crystalline counterpart? Why? (5 分)