1. Pectic substances
   a. Please sketch the representative chemical structure of pectin. (4%)
   b. What are the differences among protopectin, pectinic acid, pectic acid, and pectin? (8%)
   c. What are the basic requirements for making gel from high methoxyl pectin (HMP)? What is the mechanism for HMP gelation? (8%)
2. Calcium salts, such as $CaCl_2$, Ca lactate etc., are commonly used as firming agents during fruit processing (canning, freezing, etc). Please explain how calcium ions are able to increase the firmness of the processed fruits. (5%)
3. Many fruits and vegetables tend to brown at their cutting surfaces or after cell destruction. Please write down the basic chemical reaction formulas resulted in this phenomenon and explain the mechanism. (10%)
4. Please write down three kinds of fruit containing "lycopene", and tell me all you know about lycopene. What are the diffences in term of provitamin A activity among lycopene, α-carotene, and β-carotene? (10%)
5. What is the "antioxidant"? How the antioxidant works ? (5%)
6. How to identify the adulteration (摻假) and authenticity (真實性) of fruit juices based on their chemical compositions? (10 %)
7. Please illustrate the following reactions. (20 %)
   (1) acid hydrolysis of amylose
   (2) alkali hydrolysis of triacrylglycerols
   (3) isomerization between α-D-glucose and β-D-glucose (in solution)
   (4) Esterification in wine production
8. Please briefly answer the questions according to the following paragraphs (J. Biol. Chem. 265(26): 15770).

In general, substances of high molecular weight do not stimulate taste cells and hence have no taste. This is true for most proteins, although a limited number of proteins stimulate taste cells. One type is a protein that elicits a sweet taste. Four sweet proteins have been discovered so far: thaumatin, onellin, mabinlin, and pentadin. Another type stimulates taste cells in taste-modifying fashion; only one of these, called miraculin, had been found. Miraculin has the unusual property of modifying a sour taste into a sweet taste. Miraculin itself has no sweet taste, and the sweet proteins described above have no taste-modifying activity. Hence, it has been suggested that the two types of proteins are not related to each other.

A new taste-modifying protein named curculin was extracted with 0.5 M NaCl from the fruits of *Curculigo latifolia* and purified by ammonium sulfate fractionation, CM-Sepharose ion-exchange chromatography, and gel filtration. Purified curculin thus obtained gave a single band having a *M*r of 12,000 on sodium dodecyl sulfate-polyacrylamide gel electrophoresis in the presence of 8 M urea. The molecular weight determined by low-angle laser light scattering was 27,800. These results suggest that native curculin is a dimer of a 12,000-Da polypeptide. Curculin consists of 114 amino acid residues. Curculin itself elicits a sweet taste. After curculin, water elicits a sweet taste, and sour substances induce a stronger sense of sweetness. No protein with both sweet-tasting and taste-modifying activities has ever been found.

Questions:

(1) What are the taste differences and sweetening effects between miraculin and thaumatin, onellin, mabinlin, as well as pentadin? (3 %)

(2) What is the contribution of curculin in sweet taste compared to the proteins listed in question (1)? (3 %)

(3) How did the authors propose that native curculin is a dimer of a 12 kDa polypeptide? (6 %)

9. What could be the chemically structural requirements for food colorants? (8 %)