I. (20) Define the following terms and give an example of how each might be used to distinguish various minerals:

A. Refraction

B. Dispersion

C. Pleochroism

D. Diffraction

E. Birefringence
II. A. (10) Cuprite, Cu$_2$O, is a minor ore of copper and one of two hemi-oxide minerals. (The other one is ice.) The crystal structure of cuprite is cubic with a cell edge of 4.27Å and Z of 2. Cu$_2$O has a molecular weight of 143.09 g. Calculate the density of cuprite.

II. B. (10) The index of refraction of cuprite is 2.85, nearly the highest of any mineral and higher than diamond. What is the speed of light in cuprite?

III. (10) Calculate the 2θ angle for Cu Kα radiation (λ = 1.5405Å) for the (110) and (211) X-ray diffraction peaks of cuprite.
X (10) Below is a melting (T-X) diagram for diopside (CaMgSi₂O₆) – anorthite (CaAl₂Si₂O₈). Diopside is a pyroxene and anorthite is a feldspar so there is no solid solution between them. Starting with a liquid of composition 70% anorthite and 30% diopside at 1600°C (dot) answer the following questions based on the diagram assuming perfect equilibrium between crystals and solid:

A. At what temperature do the first crystals form? ____________________

B. How many phases are present at 1300°C? _______________________

C. At what temperature does the last liquid disappear? _____________________

D. What is the composition of the last liquid to crystallize? ________________