Print Your Last Name First Name Student Number

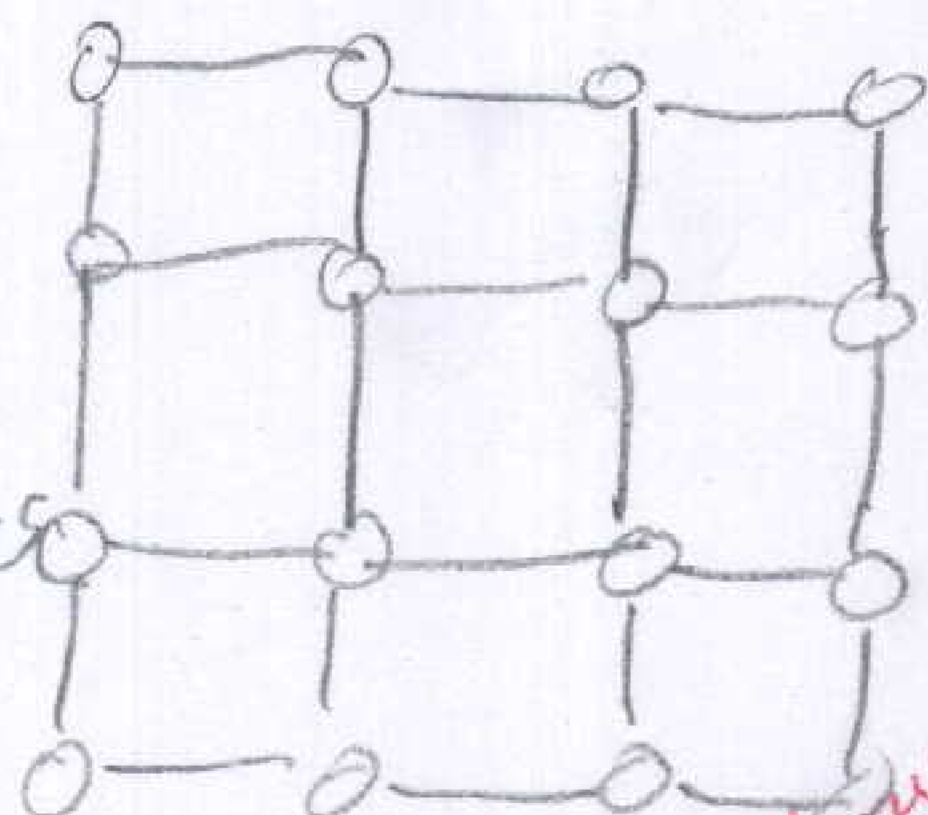
(16)

QUESTION 1

[9] 5	Sketch schematically in two-dimensions the structure of (i) Crystalline Si (ii) a-Si (iii) a-Si:H Sketch schematically the installation for a-Si:H deposition. What are the applications of this material?
[9] 5	Sketch schematically the number of atoms per unit energy vs. energy for gas molecules in a cylinder at two temperatures T_1 and $T_2 > T_1$. How we can find the average energy and where is it on the graph? Identify how you would find the number of atoms with energies greater than E_A? (assume E_A is arbitrary energy much larger than average energy)
[7] 6	Sketch schematically the dependence of the resistivity vs. the alloy composition for an isomorphous (single phase) solid solution alloy, e.g., Cu-Ni. Label your diagram clearly.

i)

Wafers in Electronics



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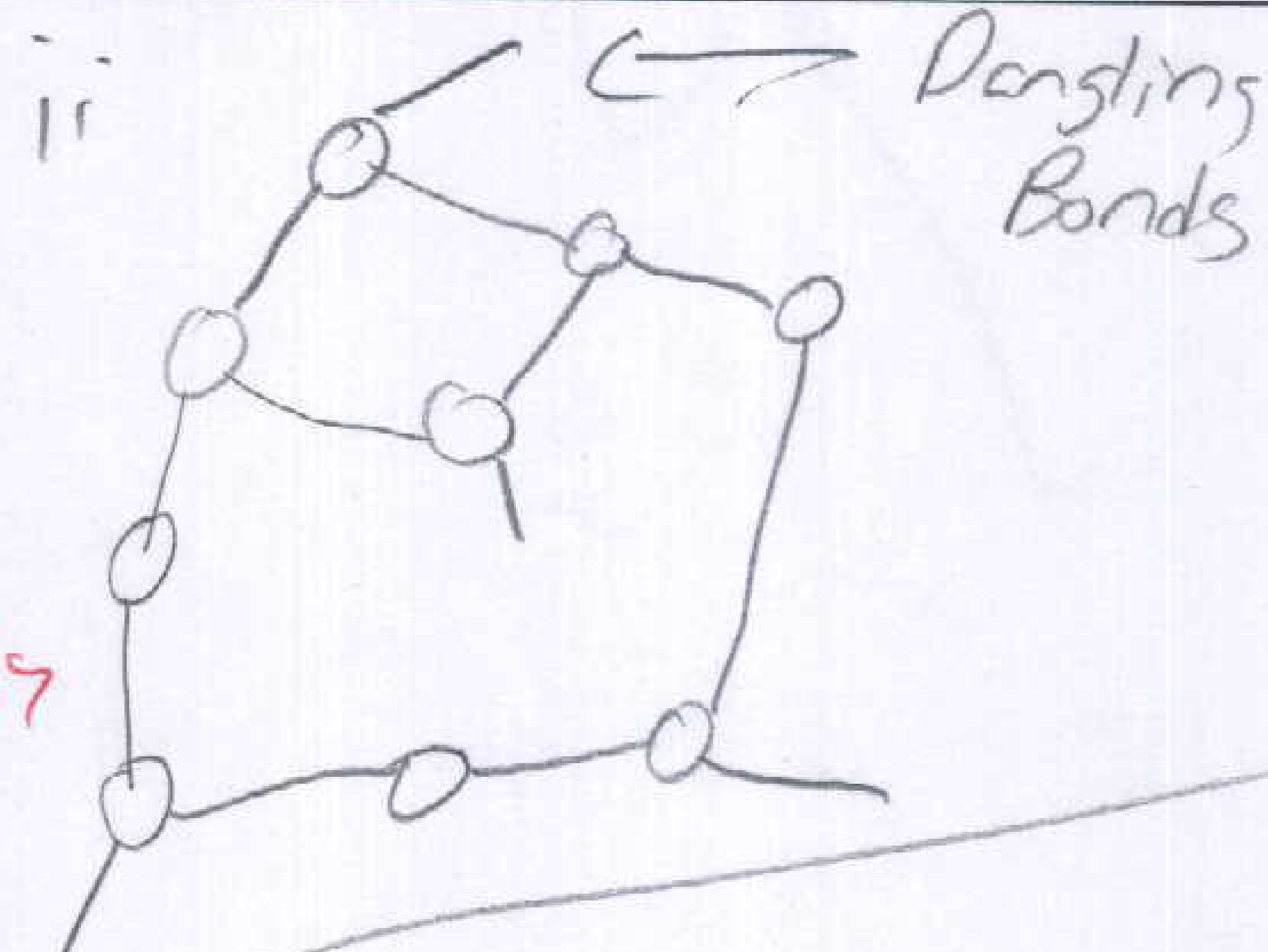

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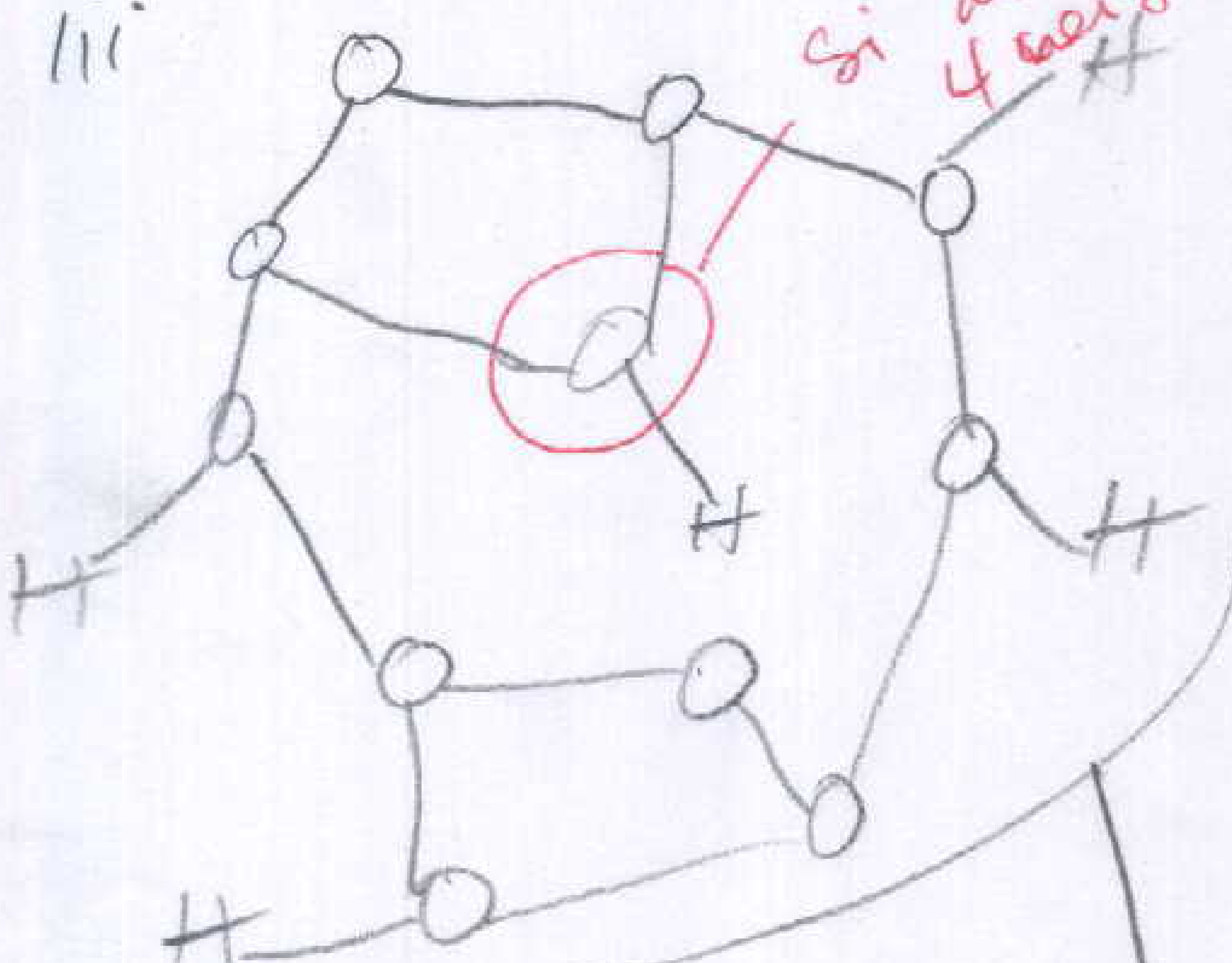
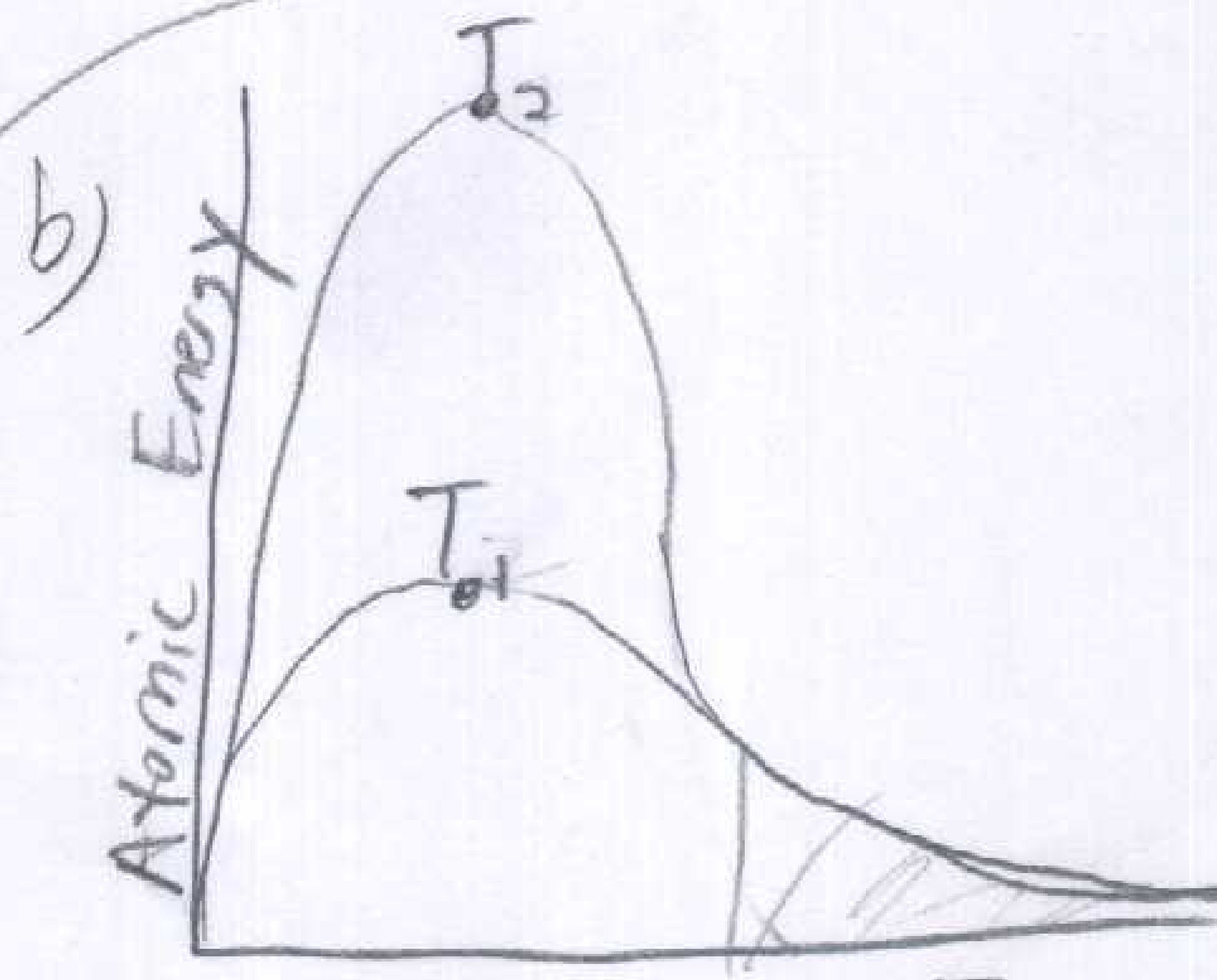
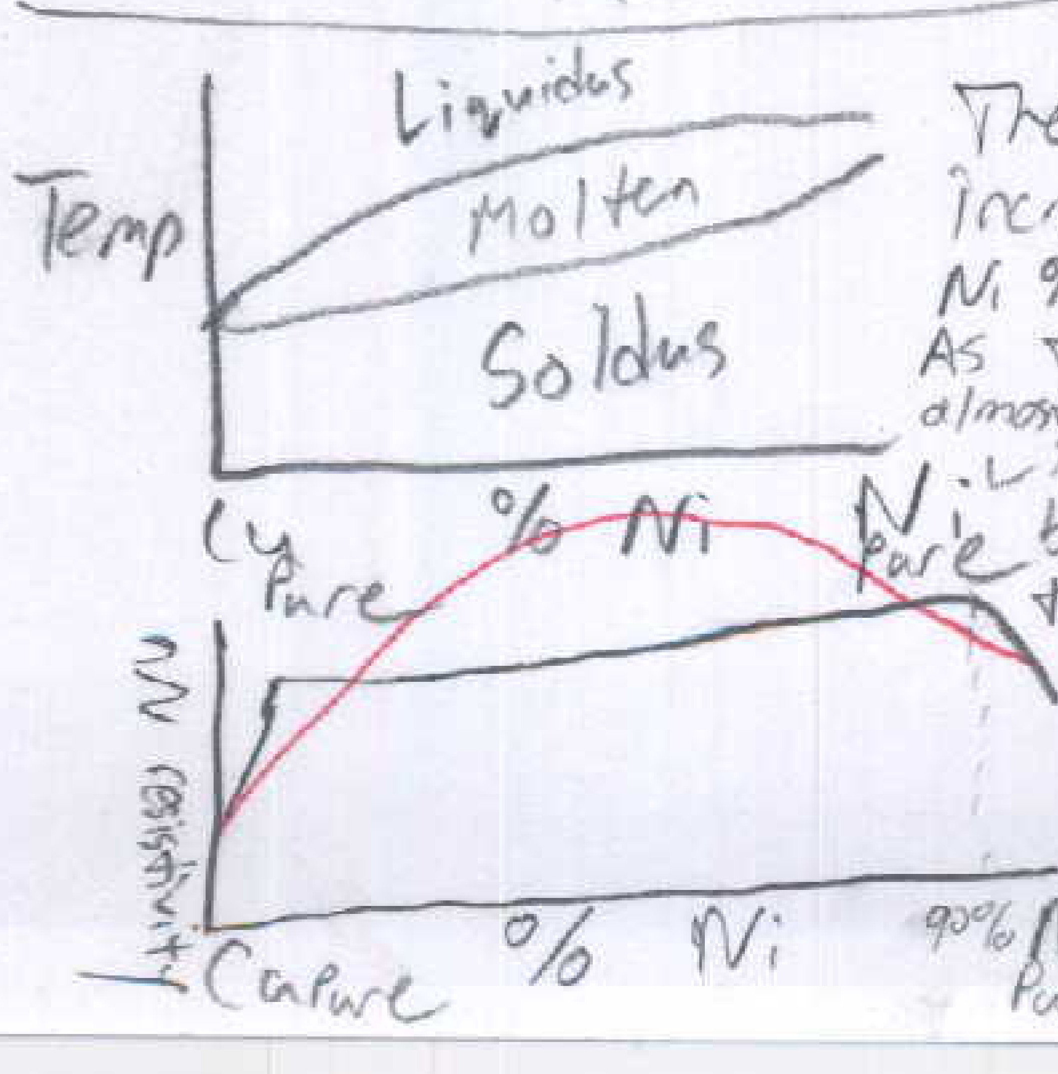


b)



~~We would find the average energy at the peak on each graph. They are labelled T2 and T1. The number of atoms with energy greater than EA would be at the top of T2.~~



The resistivity increases as the Ni % increases. As the Ni becomes almost pure it also will taper off and become less resistive than the alloy of the two.

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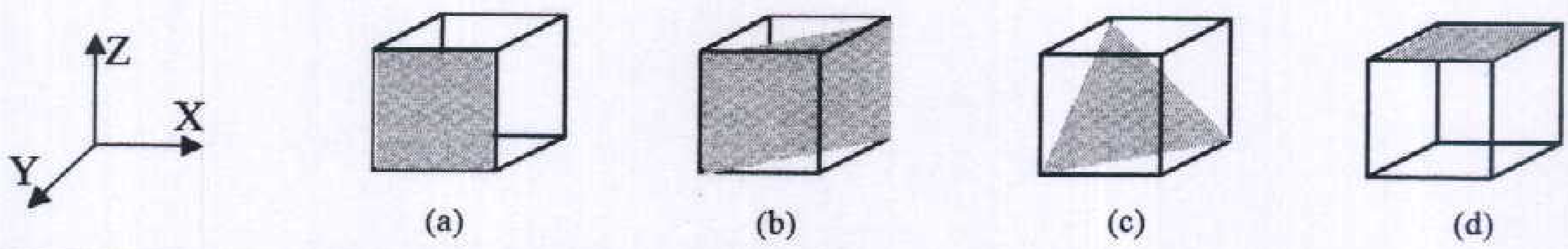
QUESTION 2

[10]	Explain briefly with clearly labeled diagrams the principle of (i) *Czochralski crystal growth technique* that is used to obtain ultra-pure silicon crystals in semiconductor fabrication and (ii) the *zone refining technique* including the distribution of impurities after first and several cycles.
[6]	Figures below show atomic planes in a cubic crystal. For each of the planes find the corresponding Miller indices. 
[9]	What is the degree of freedom? Sketch the diagram of divalent molecules and show possible degrees of freedom. What is the Maxwell principle of equipartition of energy? Using this principle derive the Dulong-Petit rule.

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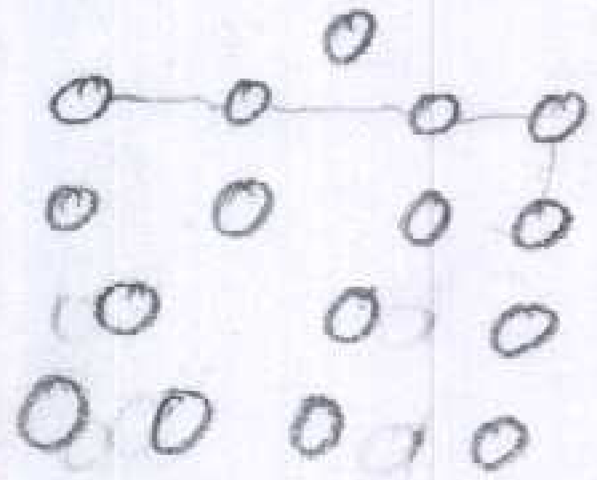
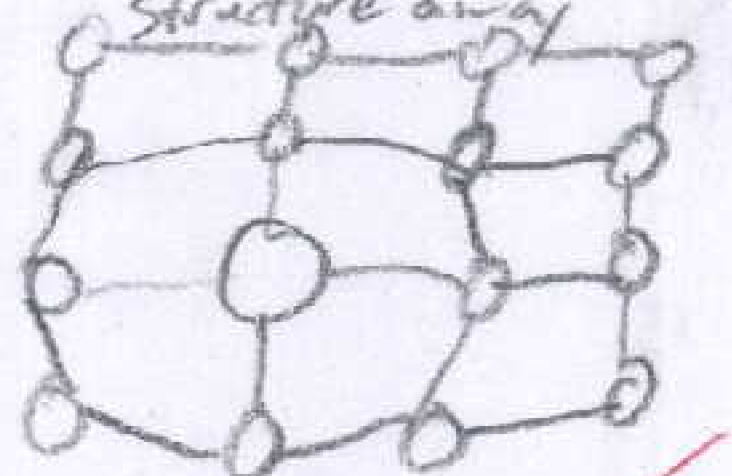
QUESTION 3

[7] 5	Sketch schematically the following in a crystal 1. A vacancy. 2. A large substitutional impurity and 3. A small substitutional impurity. 4. An interstitial impurity. 5. Edge dislocation in a crystal. 6. Schottky and Frenkel defects in an ionic crystal (e.g. NaCl) 7. Two possible (but distinctly different) ionized substitutional impurity defects in an ionic crystal
[8] 8	Plot the cooling curve (temperature vs. time) from above the melting temperature to room temperature for (i) pure Cu, (ii) 80%Cu-20%Ni. What is the difference?
[10] 0	The resistivity of copper polycrystalline thin film is known to be substantially larger than the resistivity of monocrystalline copper. Why?

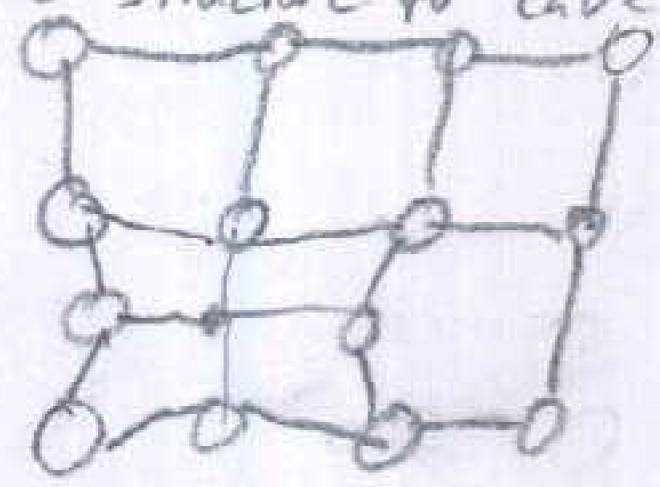
1.



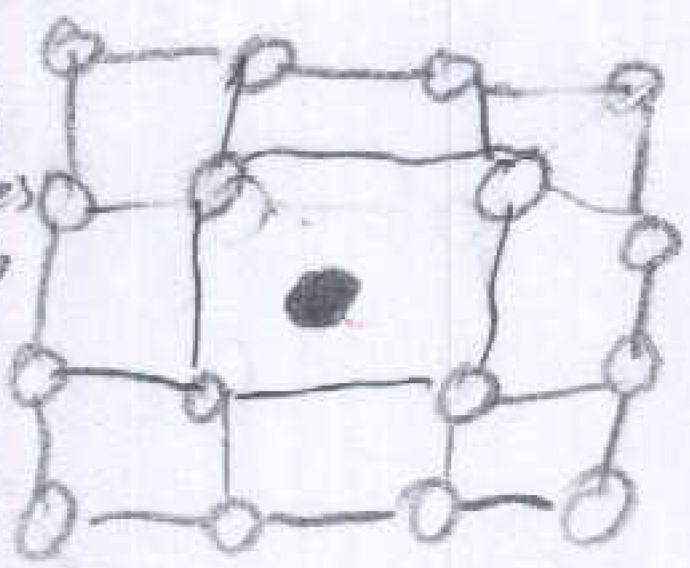
2. Large impurity pushes the structure away



3. Small impurity allows for the structure to cave inwards



4. Interstitial impurity causes structure to push away from it.



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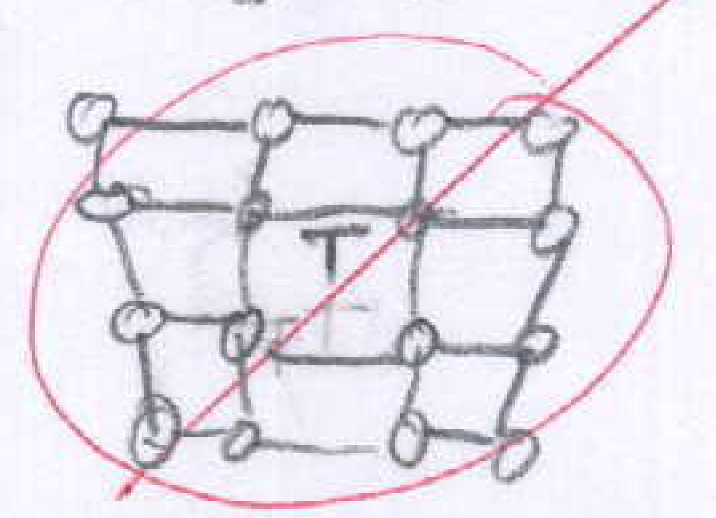

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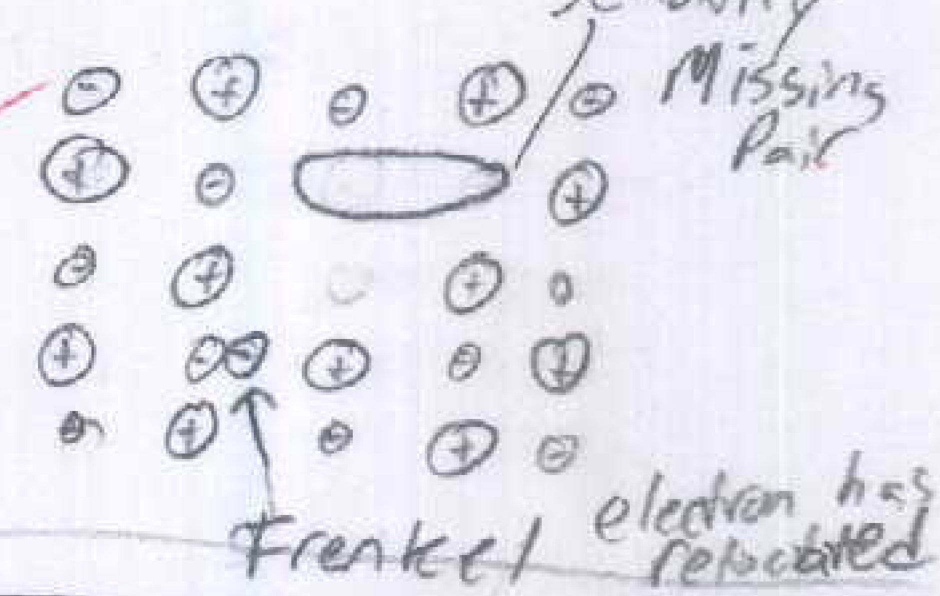

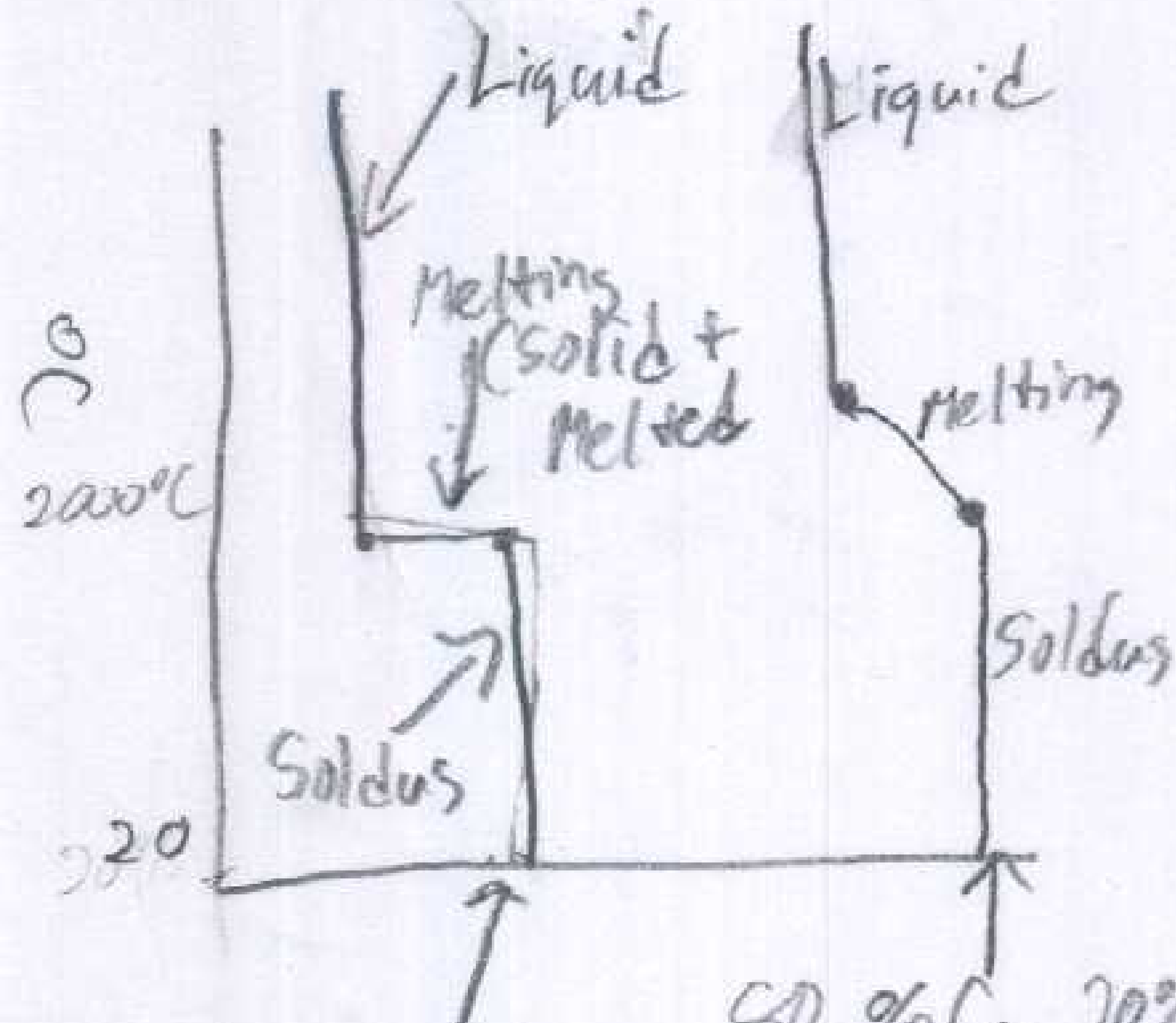

The difference is Pure Cu will melt at the same temp while the added nickel requires more heat to melt so the copper and nickel melt longer over a temperature change.

~~The resistivity of the polycrystalline thin film is higher because it has a higher concentration of atoms making it harder for the electrons to flow. The mono-crystalline copper structure allows for the electrons to pass more freely.~~