Instructor: Dr. Selis Önel
Midterm Examination, Friday, April 30, 2010

You are allowed to use an A4 size information sheet, which you have to return with the exam paper.
Please use English and give brief answers to the following questions:

Question 1. (12 pts)
Circle the correct word in the following sentence or fill in the blank:

a) Materials that have high binding energy have **high/low** strength and melting temperature.

b) Materials with ionic bonding have a particularly **large/small** binding energy due to the **large/small** electronegativity difference between the ions. Metals have relatively **higher/lower** binding energies as the electronegativities of the atoms are similar.

c) A steep slope on the force-distance curve or the stress-strain curve in the elastic region correlates with a **higher/lower** binding energy and **higher/lower** melting point, which means that a **greater/smaller** force is required to stretch the bond.

d) Smaller grain size→ **higher/lower** structural disorder

e) Smaller grain size→ **harder/lower** to move dislocations across grain boundaries due to more barriers for slip

f) More barrier for slip→ **higher/lower** material strength

g) Adding "impurity" atoms to Cu **increases/decreases** electrical resistivity and deforming Cu **increases/decreases** its resistivity.

Question 2. (16 pts)
Your boss asked you to select a material for the electrical contacts in an electrical switching device which opens and closes frequently and forcefully.

a) What are the most important properties that this contact material should have?

b) What type of material might you recommend?

c) Would Cu be a good choice, why or why not?

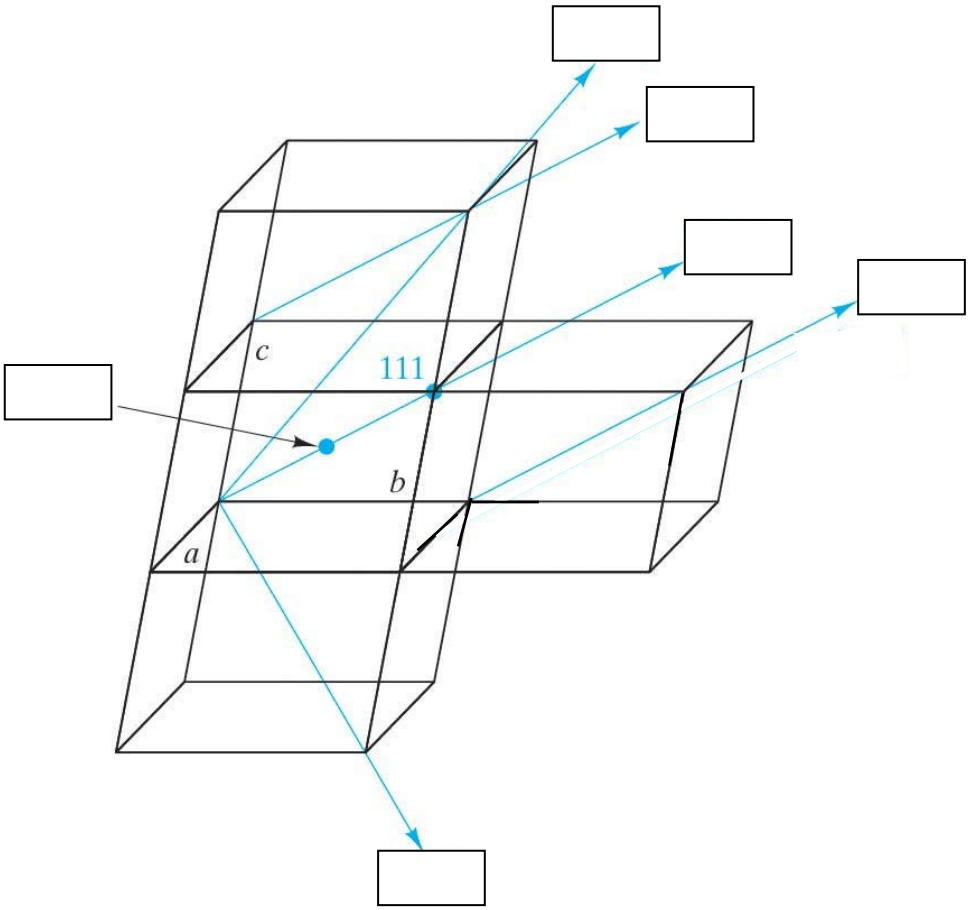
d) Would Al_2O_3 be a good choice? Explain briefly.

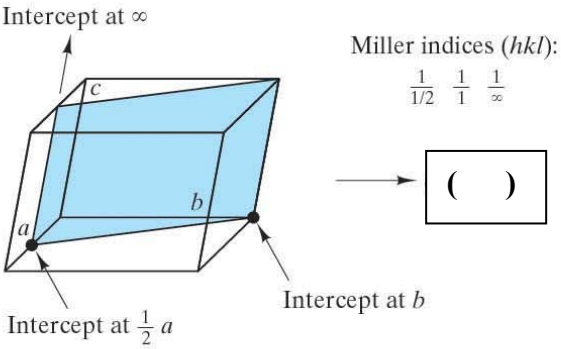
Question 3. (12 pts)
The strength of a titanium piece is found to be 65,000 psi when the grain size is 17×10^{-6} m and 82,000 psi when the grain size is 0.8×10^{-6} m. What would be the

(a) Constants in the Hall-Petch equation
(b) Strength of this titanium piece when the grain size is reduced to 0.2×10^{-6} m.

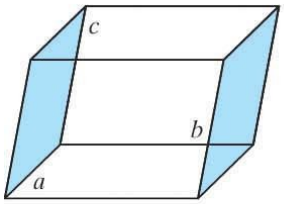
Question 4. (10 pts)
The number of vacancies in a material is related to temperature by an Arrhenius equation. If the fraction of lattice points containing vacancies is 8×10^{-5} at 600°C, determine the fraction at 1000°C.

Question 5. (25 pts)
Determine the Miller indices for the lattice points, directions and planes in the following figures. Show beneath or next to each answer box how you obtained your results (as shown in the example)





Example



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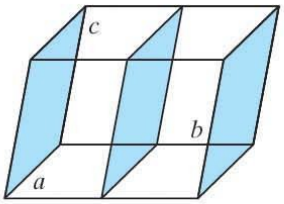

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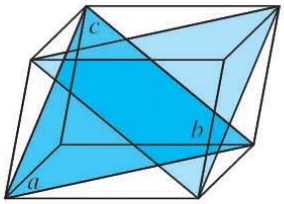

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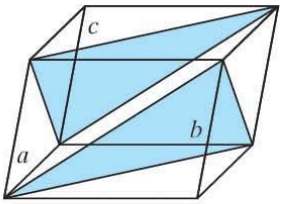

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Question 6. (25 pts)

The following XRD pattern is obtained for a sample using monochromatic radiation with wavelength of 1.5418 Å.

a) Determine the interplanar spacing for each of the peaks
b) Index each of the peaks (Determine the indices h, k, l)
c) Determine the crystal structure and select which of the following materials this sample could be: Cr, Cu, Zn
d) Determine the lattice parameter and the atomic radius