EMA 5104 Homework #1
Due Monday, September 14th at 9am

1. Give the electron configurations for Al^{3+} and O^{2-}.

2. Compute the percentage ionic character of the interatomic bond for each of the following compounds: MgO, GaP, CsF, CdS, and FeO.

3. The interatomic potential energy, U, is given by the following equation.

$$U = -\frac{A}{r} + \frac{B}{r^{10}}$$

Given that the atoms form a stable molecule at a separation of 0.35 nm with an energy of - 6.13 eV.

a) Calculate A and B.
b) Find the force required to break the bond (max force, F_{max}) and the corresponding critical separation.
c) Find the Young's modulus (E) in GPa.

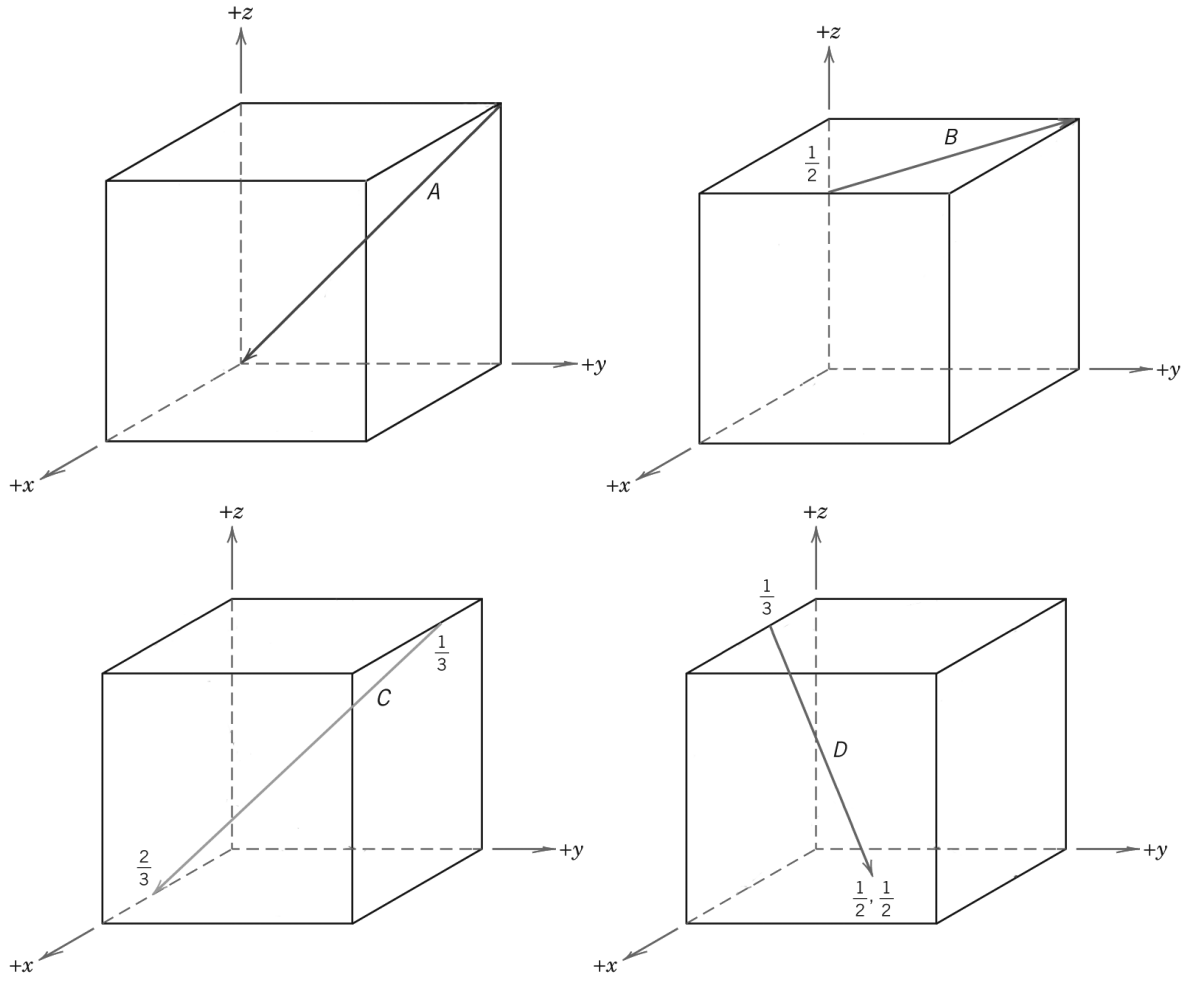
4. Explain why it is difficult to find a material with both a high stiffness and a high coefficient of thermal expansion.

5. Niobium (Nb) has a BCC crystal structure, an atomic radius of 0.143 nm and an atomic weight of 92.91 g/mol. Calculate the theoretical density for Nb.

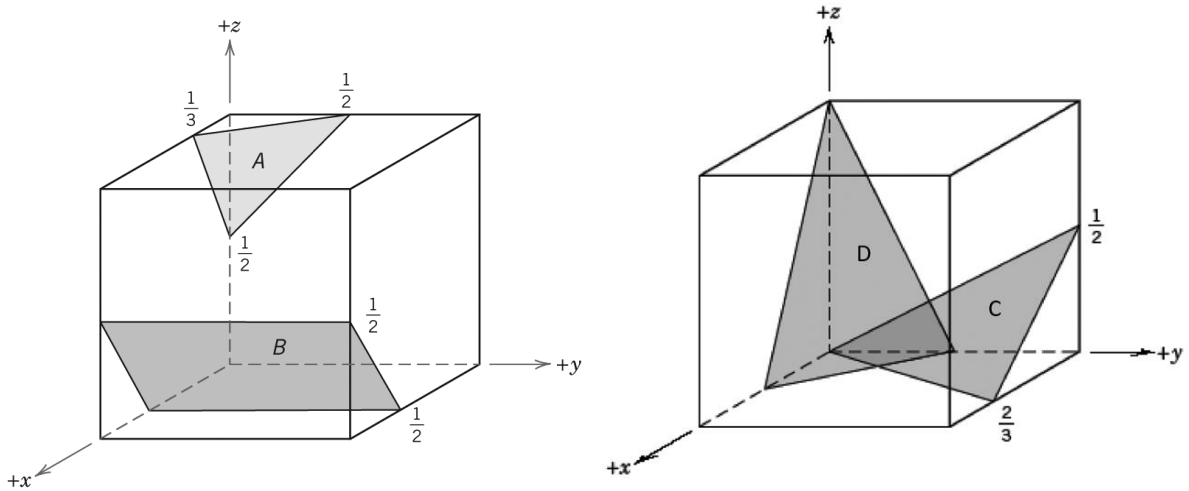
6. Draw the following planes for a cubic structure. $(0\bar{1}\bar{1}), (11\bar{2}), (\bar{1}1\bar{1}), (1\bar{2}\bar{2})$. Note: make sure to draw based on a unit cell and label the xyz coordinates.

7. Draw the following directions for a cubic structure. $[\bar{1}10], [\bar{1}2\bar{1}], [1\bar{3}3], [0\bar{1}2]$. Note: make sure to draw based on a unit cell and label the xyz coordinates.

8. Determine the Miller indices for the directions shown in the following cubic unit cell



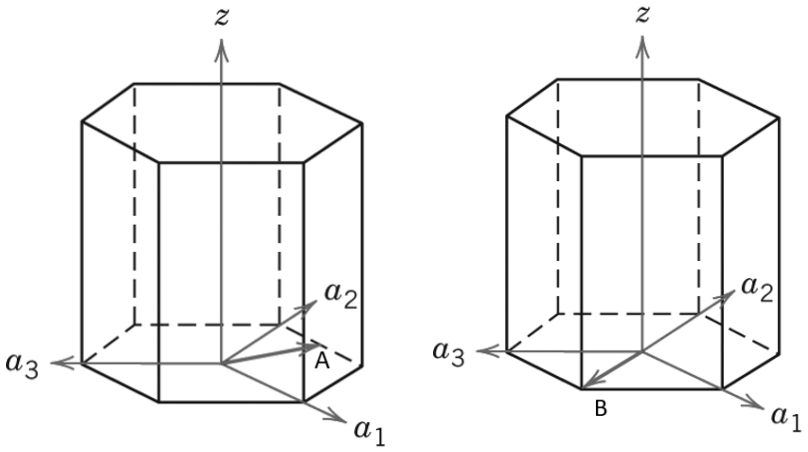
9. Determine the Miller indices for the planes shown in the following cubic unit cell



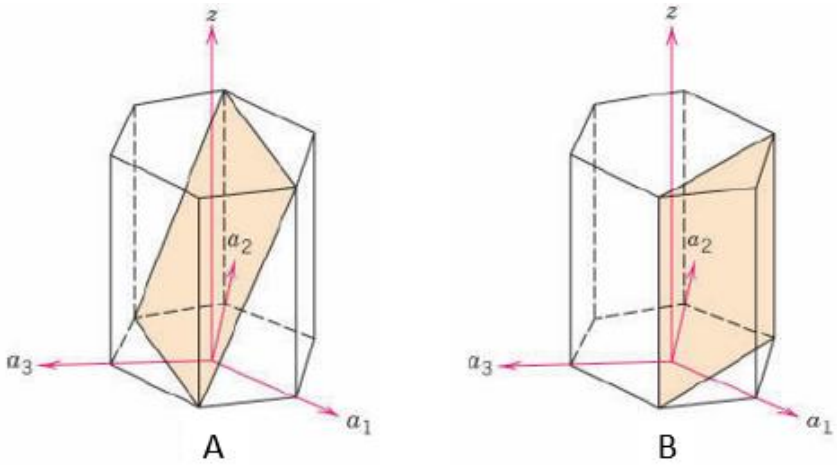
10. Find a direction that is the intersection of the planes $(41\bar{2})$ and $(\bar{2}12)$ in a cubic structure. Hint: (hkl) is perpendicular to [uvw] in cubic crystal structures.

11. Identify close packed planes and close packed directions in body centered cubic, face centered cubic, and hexagonal close packed structures. Use Miller-Bravais indices for the hexagonal system.

12. (a) Determine the indices for the directions A and B shown in the following hexagonal unit cells.



(b) Determine the indices for the planes A and B shown in the following hexagonal unit cells



13. Would you expect a material in which the atomic bonding is predominantly ionic in nature to be more likely or less likely to form a noncrystalline solid upon solidification than a covalent material? Why?