

## Survey of Materials

### Homework 1, due date is set in Canvas LMS

**Notes:** In multiple choice problems explain your answer. Add references if needed. Your solution must be uploaded as a single file “YourName.pdf” or “YourName.zip”.

1. Shape-memory alloys have their unique properties due to structural features and processes at (A) Atomistic scale (nanometers); (B) Mesoscopic scale (grain boundaries, dislocations); (C) Macroscopic scale (lateral size scale); (D) “Device scale” (entire object scale).
2. You would like to create a hard material, what elements are most important for this: (A) at the left side of the periodic table of elements; (B) right side; (C) top rows; (D) bottom rows; (E) columns in the middle; (F) rows in the middles; (G) there is no correlation with the position of elements in the periodic table.
3. What materials readily form amorphous structures rather than crystalline: (A) metals; (B) ionic solids; (C) covalent solids; (D) molecular solids; (E) polymers.
4. What materials often have effective mass of charge carriers much smaller than the mass of the electron: (A) metals, (B) semimetals, (C) semiconductors, (D) insulators, (E) superconductors, (F) graphene, (G) topological insulators.
5. Explain bonding in black-phosphorus crystal.
6. List all independent geometrical parameters of cubane molecule. What is the point group and fundamental domain (asymmetric unit) of this molecule?
7. List all independent geometrical parameters of selenium crystal. What is the space group and fundamental domain (asymmetric unit) of this crystals?
8. For c-BN crystal determine the Wyckoff positions of voids, bonds, and centers of 6-fold rings. Determine Miller indexes for planes built by two parallel bonds in 6-fold rings.
9. From the band structure shown here <http://zhugayevych.me/edu/Materials/images/bands.jpg>, determine bandgap(s) and bandwidth(s). Speculate on possible chemical composition and crystal structure.
10. In five sentences review a contributed presentation from Industry Day including: 1) motivation; 2) approach; 3) results; 4) their significance; 5) outlook (your proposal of follow-up research).