

## Survey of Materials

### Homework 2, 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. Is there a pairwise covalent bonding with octahedral coordination? (A) Yes, for example SF<sup>6</sup> molecule; (B) yes, for most of octahedrally coordinated transition metals; (C) no, because it requires *s*, *p*, and *d* orbitals to hybridize, all of them are never in resonance; (D) no, in octahedral coordination we have either non-pairwise covalent bonding such as 3c4e or non-covalent bonding such as ionic or donor-acceptor.
  
2. Calculate the relative atomic packing factor for  $\alpha$ -Mn (<http://zhugayevych.me/CryStr/Cryst/Mn.a.cif>). What is the coordination number?
  
3. At which values of parameters rhombohedral lattice transforms into a lattice of higher symmetry?
  
4. What is currently the main challenge for increasing computing power of processors per volume: (A) quantum effects due to small size; (B) overheating due to large currents; (C) inability to fabricate devices at very small scale.
  
5. What is not related to electron-phonon interaction: (A) Joule heating; (B) charge carrier concentration; (C) charge carrier mobility; (D) charge carrier effective mass.
  
6. The formation energies of possible binary compounds are:  $E(A) = 1$ ,  $E(B) = 2$ ,  $E(AB) = 2.2$ ,  $E(AB_2) = 2.3$ , and  $E(A_2B_3) = 2.4$  eV/atom. List compounds unstable with respect to phase separation.
  
7. What materials are not superconducting at normal pressure: (A) Nb, (B) FeAs, (C) MgB<sub>2</sub>, (D) SH<sub>3</sub>, (E) YBaCuO.
  
8. Elemental arsenic is not suitable for phase change memory because (A) it is metallic in crystalline phase; (B) it is poisonous; (C) the transition between crystalline and amorphous phases is too slow.
  
9. Estimate the energy splitting between the lowest two levels for an electron in a cube-shaped 10 nm Si quantum dot embedded in SiO<sub>2</sub>.