

## 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. List 3-5 most important material requirements for cathode of metal-ion rechargeable batteries.
2. List 3-5 most important material materials requirements for membrane in redox flow batteries.
3. Estimate the maximum specific energy of the battery based on  $\text{LiCoO}_2$  cathode and graphite anode. Hint: Electrode potential of  $\text{LiCoO}_2$  is 4.0 V with up to half of Li ions extractable, of graphite is 0.3 V with up to one Li per six carbon atoms insertable.
4. Calculate the EMF of an electrochemical cell composed of Zn anode and Cu cathode and write the electrochemical reaction.
5. Calculate solvation free energy for Li and Rb cations in methanol (in kJ/mol).
6. The charge of a current spike registered during nano-impact experiment in a suspension of silver nanoparticles is equal to  $4 \cdot 10^{-14}$  C. How many Ag atoms form the impacting nanoparticle?
7. What is the main reason behind a nanosize core-shell architecture for surface catalysts?
8. Using geometric arguments and basic concepts of interatomic interactions determine Li-ion diffusion pathway in anatase  $\text{TiO}_2$  (in particular list lattice coordinates of important points along the path).
9. There is also a separate set of problems for structural materials and critical materials (it will be graded separately).