

**Homework 5 Solar Power Africa (Max Yan/Sheffield-Dalhousie Questions)**  
**Due Monday September 26, 2022**

1. Explain what C-rate is and state how much time it would take to charge batteries with the following capacities and the following C-rates
  - a. 3000 mAh at 1C
  - b. 1000 mAh at 1C
  - c. 4000 mAh at 0.1C
  - d. 6500 mAh at 1.5C

What is the main assumption when talking about C-rates and how much time it takes to charge a battery?

2. A battery is capable of supplying 5A at a constant 9V for 4 hours. What is its capacity in mAh, the total charge in Coulombs and its energy density in Wh?
3. Sam decides to design a battery which can store energy while going downhill on her way to work, using a regenerative braking system. The total weight of Sam, her backpack and her bike is 72kg. The difference in elevation of her house and her workplace is 50 m. The battery she is putting on her bike will be rated to 120V. Sam wants to be able to charge her battery by 80% using the kinetic energy from her journey downhill to work. What is the total capacity Sam needs her battery to have (that is, what capacity, in mAh would her battery have at 100% charge? Assume 30% energy loss from drag, friction and the mechanical parts of her bike.
4. Sam wants to build the battery pack using Li-ion cylindrical cells, each having a voltage of 3.7V. How many cells does she need in series to give a voltage of 120V?
5. Now assume that Sam starts her journey on 0% charge. We know that a single journey will give her 80% of her total battery capacity. Sam takes 15 minutes to get to work. What is the C-rate that the battery should be able to handle?
6. What is the minimum mass of lithium that would be needed to provide the capacity of Sam's battery?
7. If the capacity could be completely stored using a graphite anode in a Li-ion cell, what mass of graphite would be required?  
What mass of silicon would be required?
8. Assuming a yield of 80 mol%, what is the mass of silica needed to produce this amount of silicon via the magnesiothermic reduction reaction?
9. Using the same assumption, what mass of magnesium is required?
10. If Sam wanted to use a lead acid battery instead, what mass of lead and lead dioxide would she need to store this amount of charge?