ECE 398GG Electric Vehicles Prof. G. Gross

Quiz 3 Spring 2023

Tuesday, April 11, 9:30 a.m.

TIME 20 minutes

1. During the performance of a cell test of a new battery prototype, you are requested by your supervisor to conduct a 5-*second* discharge measurement. Your colleague has determined earlier that the heating power generated by this cell was 10 *kW*. This cell has a mass of 5 *kg* and its specific heat capacity is 2 *kJ*/(*kg***K*). You may assume that the test starts out at the room temperature of 25 º *C*.
    a. **Compute** the energy in *Joule*s released by the battery during this 5-second discharge under the assumption of a constant current during that time period.
    b. **Determine** the change in temperature of the battery during the discharge measurement and **calculate** the final temperature of the battery.

2. For the statements below, circle each correct statement and provide a justification for each circled **and** non-circled statement. Note that an erroneous choice can still receive credit if the rationalization you state is fact based.
    a. Battery hazards and safety
        i. Batteries are passive energy storage devices, like fuel tanks.
        i. Consider an *LFP/C* battery cell whose operational range is [2,5] *V* and its nominal discharge resistance is 1 *mΩ*. The cell is used to supply a load at its max-power voltage under the usual assumptions. The cell power output

delivered this load is 7.5 *kW*. To get full credit for your answer, you must provide your calculations.

ii. Metal-oxide cathode decomposition occurs at the earlier (i.e., at the lowest temperature) at 115 º C.

iii. The highest EUCAR hazard level is 7: explosion.

b. Energy issues

i. Energy can be created or destroyed in addition to being able to be transformed from one form to another.

ii. The energy within a hydroelectric plant usually goes through the following sequence of transformations: potential energy → kinetic energy → electric energy.

iii. It is possible to have an efficiency higher than 100 *%*.

iv. Consider a system *S* that consists of a sequence of *N* subsystems connected in series. Each subsystem *s* has its own efficiency η_s. The overall system *S* has an effective efficiency of $\Pi[(\eta_s)^{-1}]$ for $1 \leq s \leq N$.