

Lead-acid batteries are widely used in sedan cars due to their reliability, cost-effectiveness, and ability to deliver high surge currents necessary for starting engines. The design of lead-acid batteries for sedan cars involves careful consideration of specifications such as voltage, capacity, energy density, and physical dimensions. Understanding these parameters helps in selecting the appropriate battery type that meets the performance needs of modern sedans while ensuring reliability and cost-effectiveness. Through proper maintenance and usage practices, the lifespan of lead-acid batteries can be maximized, making them a viable choice in the automotive industry today.

This homework assignment will cover the design specifications, performance characteristics, and numerical details relevant to lead-acid batteries used in sedan applications. Usually from data set one can find initial design point. Assume that from past information one have the following key specification (please improve the initial data if you can):

### Key Specifications

- **Nominal Voltage:** A typical lead-acid battery has a nominal cell voltage of 2.1 V. For a standard 12 V battery, which consists of 6 cells in series, the total voltage is 12.6 V when fully charged.
- **Capacity:** The capacity of automotive lead-acid batteries is usually rated in ampere-hours (Ah). A common size for sedans is around 60 Ah.
- **Energy Density:** Lead-acid batteries have an energy density ranging from 80 to 90 Wh/L and a specific energy of about 35 to 40 Wh/kg.
- **The specific power for lead-acid batteries is around 180 W/kg, which indicates the power output capability per unit weight.**
- **Physical Dimensions:** A standard lead-acid battery for sedans typically weighs around 32 lbs (14.5 kg), with approximately 60% of this weight being lead, translating to about 8.7 kg (19 lbs) of lead content.
- **Lead-acid batteries typically have a cycle durability of less than 350 cycles when deeply discharged. Regular use should avoid discharging below 20% capacity to extend lifespan.**
- **The self-discharge rate can vary between 3% to 20% per month, depending on storage conditions and battery type.**
- **Lead-acid batteries can operate effectively within a temperature range of  $-35^{\circ}\text{C}$  to  $45^{\circ}\text{C}$ , making them suitable for various climates.**
- **The charge/discharge efficiency ranges from 50% to 95%, indicating that not all energy used during charging is recoverable during discharge.**

- Maintenance Tips: To ensure optimal performance and longevity of lead-acid batteries in sedans:
  - Avoid discharging below 20% capacity.
  - Regularly check and clean terminals to prevent corrosion.
  - Monitor charging practices to prevent overcharging.
  - Maintain proper ventilation during operation.

Now for a typical lead-acid battery given above (from Data Set), calculate:

1. Total Energy of lead-acid battery when is fully charged.
2. Since the lead acid batteries are used as a starting batteries, show that for a sedan requires a starting current of approximately 400 A for about 5 s, a fully charged lead-acid battery can easily handle this requirement.
3. Using the above information and Handout#1 compute the other details if possible and recheck the above data set.
4. Draw a 3D view of your battery with all dimensions and detail if possible.