

Problem 1 Solution

This problem provides too much information and so we ignore the unnecessary data. Given the traction power for each speed v and the drivetrain efficiency together with the additional 1-kW hotel load we have all the data we need. The available energy of the battery that may be used is $(100 - 20)\%$ of the storage capability of 40 kWh \Rightarrow 32 kWh.

For a speed v , and the traction power P_t , we compute

$$P_{\text{battery}}(v) = \frac{P_t(v) + 1}{0.9} \quad \text{for a value of } v$$

For one hour at cruising speed v , the energy withdrawn from the battery is \leftarrow

$$P_{\text{battery}}(v) \cdot 1 \text{ kWh}$$

The distance covered in 1 hour is $v \cdot 1$ and so the ratio

$$\frac{P_{\text{battery}}(v)}{v} \frac{\text{kWh}}{\text{mile}} \quad \text{is the fuel economy of the EV}$$

and the range $r(v)$ is obtained from the ratio of energy/fuel economy

$$\frac{32,000 \text{ kWh}}{P_{\text{battery}}(v)} \cdot v = \text{range}(v) \cdot \left(\frac{v}{\text{fuel economy}} \right)^{-1}$$

of hours for discharge

v	$P_{\text{battery}}(\text{kW})$	range(mi)	
45			\leftarrow not needed because $\frac{\text{range}(70)}{\text{range}(45)}$
70	19	118	$\frac{\text{range}(70)}{\text{range}(75)} = \frac{\text{range}(70)}{\text{range}(75)}$
75	46.1	52	$\frac{\text{range}(45)}{\text{range}(75)}$

$$\frac{118}{52} = 2.27$$

Problem 2: 80 points

For the statements below, circle each correct statement. We discourage guesses and it helps if you provide a justification of why you chose to circle or not circle the statement.

A. The 2020 *US* electricity generation had

- about 40 % from CO_2 -free source
 - True
- about 60 % from fossil fuel as the primary energy source
 - True
- hydroelectric generation as the largest source of renewable energy
 - False
- solar energy provided nearly 4 times as much energy as that provided by wind
 - False

B. The following statements are on the *US GHG* emissions expressed in *metric tons CO_2e* :

- the transportation sector *GHG* emissions exceed those from the electricity sector since 2013
 - False
- the estimated 2021 *GHG* emissions indicate an increase over the actual 2020 value
 - True
- during the 2019 – 2021 period, the *GHG* emissions from buildings were about equal to those from the electric power sector
 - False
- the estimated 2021 *GHG* emissions indicate an increase over the actual 2019 value
 - True