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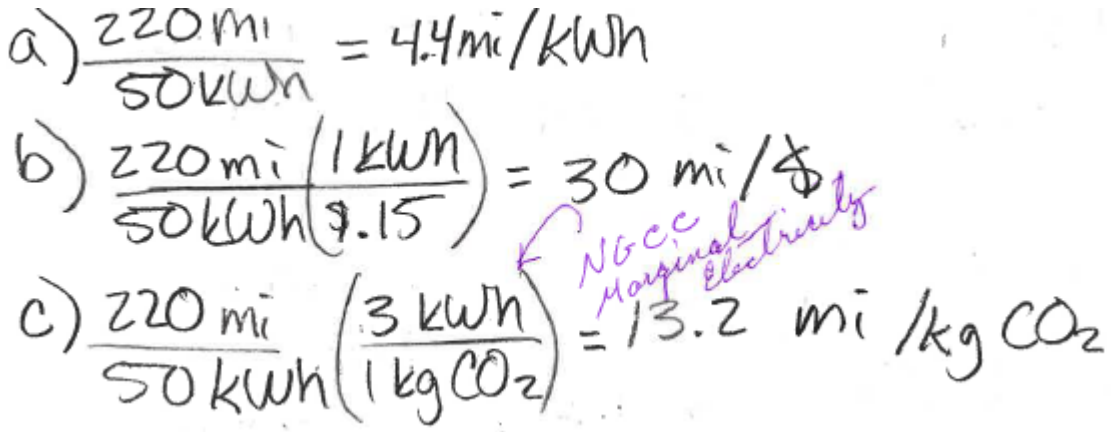
1) Wikipedia claims that one version of the Tesla Model "S" has a 50 kWh battery and a range of 220 miles. Please calculate the following:
   a) Mileage in miles per kWh ~4.4 mi/kWh,
   b) Mileage in miles per $ Assume paying $0.15/kWh, about 30 mi/$
   c) Mileage in miles per kg of emitted CO_2. Assume using NGCC in California, so 1/3 kg(CO_2)/kWh. Again, many people tried to calculate this ratio over again from 15g(C)/MJ(th), and it takes way longer, and most folks leave a step out and get the wrong answer. I'm trying to help you get an "on the street" ability to use these numbers.



2) HFCV (Hydrogen Fuel Cell Vehicles): Many people answered these questions in terms of public support rather than technological reasons… for instance, I didn't accept answers such as "people are used to BEV and are afraid of hydrogen". I'm looking for technology, physical answers.
   a) How are these vehicles physically like a BEV (battery electric vehicle) Both are electric vehicles
   b) How are HFCV physically different from a BEV? BEVs are charged by electricity and HFCV are charged with hydrogen. BEV have batteries that move Li^+ ions back and forth, HFCV move H^+ ions one way (and then the water leaves the system.
   c) Why is HFC technology compelling for the future? You can charge it quickly like an ICE, so there will be no range anxiety (once there are ample fueling stations). Many people equated abundant hydrogen (in HFCV) to lithium… these are not analogous. Hydrogen is analogous to electricity (how you fuel it). The lithium is more analogous to the platinum – how it's processed in the vehicle. Both lithium and platinum are rare and expensive. Hydrogen and electricity are the relatively inexpensive fuels.
   d) Why might HFC technology never take off? HFCV face a number of challenges: producing H_2 (presently through natural gas reformation, which produces CO2, but also can be made by electrolysis or by using a HFC in reverse, but these are less efficient than battery storage), transporting H_2 (Colorless, ordorless, combustible gas), storing H_2 in the vehicle (requiring very high pressure… presenting weight and explosion challenges), and converting it… Pt is very expensive and also the H_2 has to be very pure so as not to poison the HFC membrane.
   e) Is HFC energy compelling for anything besides cars? Why or why not? If space is not an issue, then HFC are easier. In general, fuel cell technology may be good for land based, space based, or even large boat based use because you can store lots of fuel. For instance, after the duck's belly is on the ground, we really do have free electricity. Then you don't care if creating hydrogen gas via a HFC is inefficient. You can store the energy very cheaply in super large caverns or low-pressure tanks to convert back to electricity (inefficiently) with HFC in the evening. Some students said that they already use them in space… is this true?

(a) both drive the wheels with an electric motor and suffer from convenience/range issues during road trips under the current infrastructure. Neither emit CO_2 directly from the exhaust

a) Fuel cells work like a battery (proton goes across membrane and electrons used to drive motor) and can ~~be~~ energy can be created from electricity

b) have to store hydrogen rather than electricity in ~~the~~ hydrogen tank, more issues refueling, use hydrogen instead of lithium ions

c) Only emissions are H_2O so they are clean as long as you ~~create~~ obtain hydrogen in clean way hydrogen could be obtained via clean electricity

d) Several difficulties ie hydrogen must be very pure, you can't put in a tracer gas cause it would clog ~~a~~ fuel cell, catalyst is expensive, hydrogen is hard to store, efficiency going from electricity to hydrogen is not very high or inexpensive

e) If hydrogen was created from clean electricity and stored and used as a battery maybe, but overall it is probably a worse option than using a battery because of reasons listed in d. (low efficiency and cost)

a) They are similar to BEVs in that the output is electricity and they don't use a conventional internal combustion motor. They have (in theory, but depending on how hydrogen is produced) lowered CO_2 emissions like BEVs. Electric motor, but intake is hydrogen not electricity. Also like BEV's, the range is a little lower than ICE's.

b) instead of a battery that uses electricity like BEVs, HFCV's use hydrogen to get an electric output. BEVs use like lithium ion batteries to power the motor, HFCV's use fuel cell / hydrogen technology

c) lowered CO_2 emissions! Hydrogen can be extremely good as a future application for lowering CO_2, but figuring out the source of hydrogen is difficult.

d) There needs to be a sustainable way to get hydrogen to power the cars If it is produced from NG, why not just use electric cars that already have infrastructure set up? Need charging stations and right now the cars are very expensive bic they aren't commercialized. It might never take off bic the expenses in figuring out when to get hydrogen & setting up hydrogen fueling stations.

e) I'd say it is because if we are looking for sources to generate power with lowered CO_2 emissions, hydrogen/ fuel cell technology has shown it can do that, it just needs a sustainable hydrogen source. Perhaps fuel cells can be used for less of a consumer application so less infrastructure (charging stations) needs to be set up.