Energy Density and Liquid Fuels

Pre-Race Checklist

Please answer the following questions individually

PR.1. What does "energy efficiency mean"?

PR.2. Is energy efficiency the same thing as using less energy? Explain why or why not.

PR.3. Compare the energy use of two cars using different fuels. Is it possible for one car to use more fuel, but less energy than the other?

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Start Your Engines…

The American Le Mans Series encourages teams to use different types of fuels. To make the race fair, gas tank size is different for different types of fuels so that every car carries the same amount of energy, as opposed to the same amount of fuel. The three most-used fuels are E10 (a 10% by volume blend of ethanol and gasoline), E85 (85% ethanol) and low-sulfur diesel.

A. **Using data from the table of energy densities, find the volumetric energy densities for E10, E85 and diesel fuel. Make sure you're using the values for the ALMS fuels at the bottom.**

B. **Rank the tank sizes for the three fuels. Which will be largest and why? Estimate how much larger the biggest tank will be relative to the smallest without doing any calculations.**

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C. Cars that use E10 fuel are required to have 90-liter gas tanks. Calculate the size of the tanks for GTL diesel and cellulosic E85 so that all cars carry the same amount of energy per tank.

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D. Two teams go the same distance on a tank of fuel, but one team is using cellulosic E85 and the other is using GTL diesel.

D.1. Which team used more fuel and why?

D.2. Without doing any calculations: Which team do you think used more energy? Explain your reasoning.

D.3. Calculate how much energy each team used.

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E. Team A goes 16 km (about 10 miles) using 4.37 liters of E10. Team B goes the same distance using 5.20 liters of E85.

E.1. Which team got better gas mileage?

E.2. Which team was more energy efficient?

E.3. The idea that it is possible for a car to use more fuel, but less energy is counter-intuitive. Write an explanation that broadcasters could use on television to explain this concept to the audience.

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Back to the Garage

Let's use these same principles to explore the impact of energy density on passenger cars.

A. How much energy does a 13.0-gallon (49.2 L) tank hold when filled with conventional gasoline?

B. How large a tank would you need (in liters) to hold the same amount of energy you found in part B if the tank were to be filled with E10?

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C. How large a tank would you need (in L) to hold the same amount of energy you found in part B if the tank were to be filled with E85?

D. If a car gets 21.0 miles per gallon (8.92 km/L) using conventional gasoline, what would the mileage be if the same car were using E85? Assume that the car has the same efficiency for both fuels. Express your answer in terms of miles per gallon.

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E. A commuter drives the car mentioned in part D an average of 39 miles every day. The car has a 13.0-gallon (49.2 L) gas tank. If the driver needs to fill the tank once every seven days using conventional gasoline, how often would she have to fill the tank if she were using E85?

F. If gasoline costs $3.30/gallon and E85 costs $2.10/gallon, which fuel is the better bargain?

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Extension A: Liquid Propane vs. Gasoline

If liquid propane can be bought for $2.62 per gallon and gasoline costs $3.10 per gallon, which is the better value?

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Extension B: Miles per Gallon

Does the efficiency of the car make a difference in the mileage? In other words, is it more economical to switch to E85 in a car that gets 21.0 miles per gallon than it would be for one that gets 40 mpg?

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Extension C: Blending Fuels

BP introduced a racing fuel for the American Le Mans Series that is 20% butanol (by volume) and 80% ethanol called iBE20. Predict the density and volumetric energy density of iBE20.

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