**Pre-Activity Problem Set**

## Answer the following questions.

1. What is the chemical equation for complete combustion?
2. What pollutants might result if incomplete combustion is occurring?
3. Is NOx formed from the fuel itself? If not, where does it come from? Yes or No
4. Which fuel has a higher energy content? Gasoline or Diesel

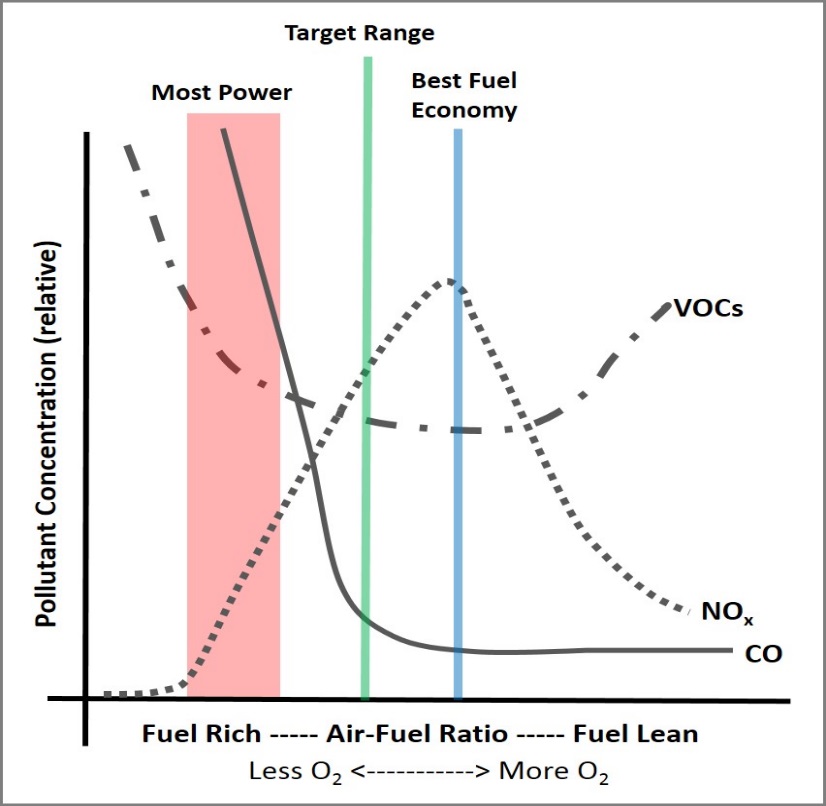
Answer the following questions using the example data in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Independent Variables** | | | **Dependent Variables  (concentrations observed at tailpipe)** | | |
| **Fuel** | **Formula** | **Combustion temperature (°C)** | **CO2 (ppm)** | **VOC (ppm)** | **NOx (ppm)** |
| Case 1: Gasoline | C8H18 | 1500 | 3000 | 30 | 20 |
| Case 2: Diesel | C12H23 | 1900 | 3000 | 50 | 40 |
| Case 3: Ethanol | C2H5OH | 1500 | 4000 | 10 | 20 |

1. What is similar about the chemical formulas for all of the fuel sources?
2. What is different about ethanol, and why might that difference result in lower VOCs?
3. Which requires more oxygen to reach complete combustion? Gasoline or diesel? And, why?
4. Which fuel type results in the most NOx and why?
5. In the following table, circle the **A** or **B** that best completes the row. Then explain your rationale.

|  |  |  |
| --- | --- | --- |
| **Claim** | **Evidence** | **Reason** |
| Vehicle 1 produces more total pollutants than vehicle 2. | We observe higher CO2 *and* higher VOCs in the vehicle 1 data. | 1. **Vehicle 1 has an older engine.** 2. **Vehicle 1 has a larger engine.** |
| Vehicle 2 exhibits more complete combustion than vehicle 1. | 1. **We observe more VOCs from vehicle 1 than vehicle 2.** 2. **We observe more VOCs from vehicle 2 than vehicle 1.** | Vehicle 2 is newer and operating more efficiently, therefore it is displaying more complete combustion. |
| 1. **The combustion in vehicle 1 is hotter.** 2. **The combustion in vehicle 2 is hotter.** | We observe more NOx from vehicle 1 than vehicle 2. | Vehicle 1 has a diesel engine. |

**Explanations**

**CHALLENGE QUESTION**

1. To the air-fuel ratio plot on the right, add a line for CO2. Explain your line placement.