**Fuel & Biodiesel Midterm Objectives:** By the end of this unit, students will be able to…

1. Define the following: energy, work, and matter.
2. Define and provide examples of the first and second law of thermodynamics.
3. Define and summarize the concept of entropy.
4. Describe the relationship between energy transformation and entropy.
5. Compare and contrast kinetic and potential energy.
6. Define enthalpy and bond energy.
7. Compare and contrast bond energy and enthalpy and describe when energy is absorbed and when it is released in a chemical reaction (particularly in regards to when bonds are formed and when they are broken).
8. Compare and contrast endothermic and exothermic reactions.
9. Explain why light and heat are given off during combustion using the concept of bond energy, enthalpy, and exothermic reactions.
10. Define activation energy and provide examples.
11. Use enthalpy and bond energies to explain why it is not feasible for water to be a sustainable source of combustible fuel.
12. Define petroleum and explain the conditions under which it was formed.
13. Summarize the processes in which petroleum products are created.
14. Defend why petroleum is the primary source of energy in the US.
15. Summarize how petroleum use is related to current atmospheric carbon dioxide levels.
16. Explain the meaning of a carbon neutral fuel and summarize why it is of interest at the moment.
17. Summarize the concerns related to the fact that petroleum fuels contain nearly every element on the periodic table, particularly in regards to biomagnification.
18. Utilize the molecular properties of fossil fuels to explain why they are a primary cause of air pollution.
19. Summarize the environmental and health impacts related to the acquisition and use of petroleum.
20. Predict the future of petroleum use based on current trends.
21. Assess the sustainability of fossil fuels by providing five pieces of evidence as to whether or not fossil fuels are sustainable.
22. Define and summarize the properties of shale oil.
23. Predict the most likely future for the supply of US Shale Oil based on federal data.
24. Given fossil fuels are limited in supply, cause significant environmental damage, are a leading cause of climate change, and are damaging to human health, provide justification for why they are used so prominently in the US.
25. Summarize five characteristics that an alternative to a fossil fuel would have to have in order to replace most fossil fuel use.
26. List and describe the three components of sustainability.
27. Define life cycle assessment and summarize the meaning of inputs and outputs in LCA.
28. Conduct a LCA for everyday activities in which you partake and alternatives for those choices.
29. Compare each of the following fuels, provide a summary of their properties and characteristics, and summarize their benefits and drawbacks: a. Petroleum b. Shale Oil c. Biofuel d. Electricity e. Hydrogen
30. Using your understanding of each of the fuels above, choose the fuel that you think would best provide a dependable and sustainable source of fuel in 2050.
31. Using your understanding of each of the fuels above, choose the fuel that you think would be least capable of providing a dependable and sustainable source of fuel in 2050.
32. Compare and contrast the spark ignition engine and the compression ignition engine based on their properties and function.
33. Summarize what happens during each of the four strokes of a four stroke engine.
34. Explain the technological advancements that have improved the performance of the compression ignition engine.
35. Utilize the mechanism of the compression ignition engine to explain why they have a higher fuel efficiency than a spark ignition engine.
36. Summarize how dark smoke relates to the rate of combustion of a fuel.
37. Define biodiesel, summarize how it is made, and explain the sources that can be used to make biodiesel.
38. Summarize the steps and chemical reactions involved in transesterification.
39. Identify a transesterification reaction based on changes to the molecules involved and summarize how transesterification changes the chemical structure of a triglyceride molecule.
40. Identify the chemical structure of an ester.
41. Summarize the role of each of the following in transesterification: base, alcohol, triglycerides.
42. Summarize the efficiency of the transesterification reaction.
43. Explain why biodiesel molecules combust more completely and efficiently than petroleum diesel fuel.
44. Describe why biodiesel can lengthen the life of an engine.
45. Explain the properties of biodiesel that can enable it to be carbon neutral.
46. Summarize why biodiesel is a safer fuel than petroleum diesel fuel.
47. Define each of the following: a. Flashpoint b. Lubricity c. Cetane Number
48. Compare and contrast the benefits and disadvantages of biodiesel compared to standard diesel fuel.
49. Summarize the developments in biodiesel research and use this understanding to predict the future role that biodiesel will play in US transportation energy.