

Group 1 Problems- Scientific Research and Development (60 pts)

1. (20pts) Read chapter 13.3 Biomass as a Fuel in textbook- pp.556-574 Answer these questions
 - 1a. (7pts) Does using Biomass fuel such as biodiesel add CO₂ to the atmosphere? (Yes/No)
 - 1.b (7pts) What is the main reason truck makers use biodiesel and not straight vegetable oil (SVO)?
 - 1.c (6 pts) What process could be used to make the straight vegetable oil an alternate to biodiesel?

2. An automobile can be fueled by dissociated alcohol (p556) at 350 deg C. Consider liquid methanol that is catalytically converted to hydrogen gas and carbon monoxide. 2.1(12 pts) Complete Table 2.1

Table 2-1 Fuel Comparison	Methanol	Hydrogen	Carbon Monoxide
Lower heat of Combustion	(liquid)		
Entropy	(gas)		

2.2 (8pts) Does Methanol dissociation increase Total Entropy & Heat of Combustion?

3.1 (15 pts) Calculate the spark-ignition engine efficiency $\eta = 1 - r^{1-\gamma}$ eq. (3.1); r is compression ratio and γ : specific heat ratio = 1.2 for gasoline and methanol, 1.7 for dissociated methanol in Table

Table 3.3	Gasoline	methanol	DissociatedMethanol	methanol	DissociatedMethanol
Comp ratio	$r=9$	$r=9$	$r=9$	$r=12$	$r=16$ (lean)

3.2 (5pts) The highest engine efficiency in Table 3.3 is for? Note: Max power @ $r=12$ (rich)

Group 2 Problems- Renewable Energy Process (20pts)

4. Biomass and Municipal Solid Waste (MSW) in DC area is

Item	1. Paper waste	2. Cardboard	3. Yard waste	4. Glass	5. Food Waste
%Mass	35	30	25	5	5
%H ₂ O	5	5	60	0	65
Density kg/m ³	100	50	150	200	400
Heat Value KJ/kg	18000	18000	7000	200	5000

4.1 (6 pts) Estimate the density of MSW kg/m³ as collected -The MSW is then compacted to 700 kg/m³

4.2.(7 pts) Estimate the higher heating value KJ/kg of the MSW

4.3 (7pts) Estimate the value of CO₂ released by burning 1000 kg of MSW.

Group 3 Problems - Technical Support and Sales (20 pts)

Table 5.1 Automotive data -Source Electric & Hybrid Vehicle Technology International -July 2016

Hybrid*	2016 Prius 97ps*	BMW x-5 (248ps)*	VolvoXC90 (324 PS)*	Toyota Mirai 113kW
Gal /mile	113 advertised	85.6 /30mile battery	134 /27 mile battery	79/hydrogen Fuel Cell
CO ₂ g/Km	70g/km	77g/kmCO ₂	49g/km CO ₂	0 CO ₂ /km -water

The Electric Hybrid - fuel cell vehicles in Table 5.1 are being tested. Discuss in three paragraphs:

4.1 (6 pts) Will 80 mpg fuel consumption and 70 g/km CO₂ be met in this generation of cars?

4.2 (7 pts) Do electric cars actually reduce CO₂ or simply transfer CO₂ - to the electric power plant

4.3 (7pts) Assuming Hydrogen fuel is available, what are the advantages of the fuel cell powered car?