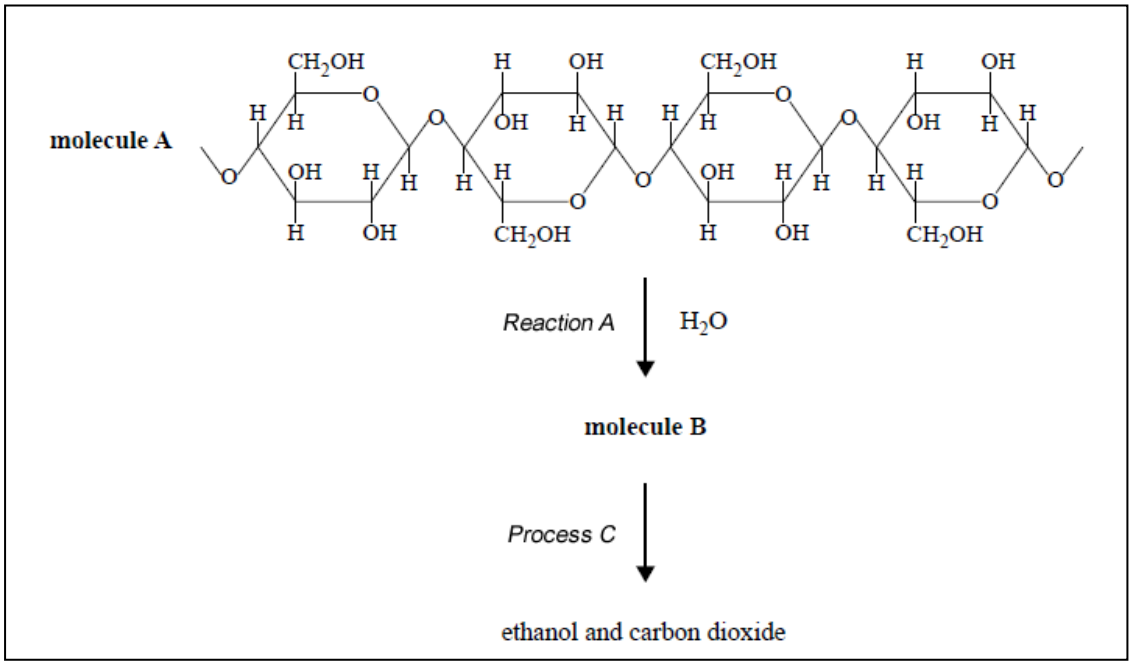
Friday Worksheet **Name: …….**

Biofuels worksheet 1



1) Biochemical fuels, such as bioethanol, can be produced using pulped plant material. Consider the biochemical pathway, shown above, which converts substances available in pulped plant material to ethanol.
a) What is the chemical formula of molecule B? $C_6H_{12}O_6$
b) What type of reaction is reaction A? Hydrolysis
c) What is the name of process C? Fermentation

2) It is argued that ethanol produced in this way could be considered renewable and carbon neutral compared to other fuels such as petroleum.
a) Explain why this form of ethanol production can be considered renewable and carbon neutral. A fuel is termed renewable if it can be replaced by natural processes in a reasonable time frame so that reserves do not run down. Carbon neutral is the term used for fuel that does not increase the net amount of carbon dioxide in the atmosphere. A fuel that has being produced through the process of photosynthesis will tend to be carbon neutral as the carbon dioxide removed from the air, during its synthesis, will be returned to the atmosphere during its combustion.

b) Discuss the advantages and disadvantages of using energy resources such as bioethanol.
Bioethanol is a carbon neutral fuel and is renewable. Disadvantages include the competition for land for crop growing,
Ethanol has **a lower** molar enthalpy of combustion (1364 kJ/mol) than octane (5464 kJ/mol) and most other hydrocarbons so more is needed.

3) Wood pulp is used by bacteria to produce ethanol. 1.40 kg of wood pulp is used in the process and 428 mL of liquid ethanol is collected. A sample of 6.28 mL of this ethanol is then completely combusted in a bomb calorimeter. One litre of water was heated from an initial temperature of 22.00 °C to 59.20 °C.

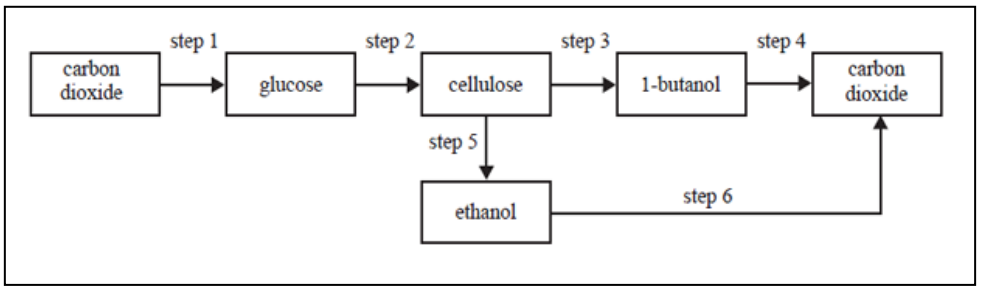
a) Write a balanced chemical equation for the combustion of ethanol.
$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

b) What was the amount of energy produced by 6.28 mL of bioethanol that was completely combusted in the bomb calorimeter
Energy = 4.18 X 1000 X 37.20 = 155.5 kJ

c) Using the molar heat of combustion of ethanol, determine the mass of ethanol present in the 6.28 mL sample.
Step 1 determine the mol of ethanol.
=> one mol of ethanol produces 1360 kJ of heat energy.
=> so *155.5 kJ of energy must have come from 155.5/1364 mol of ethanol*
=> 0.114 mol of ethanol.
Step 2 find the mass of ethanol
=> 0.114 X 46.0 g/mol = 5.26 g

d) Ethanol produced in this way is known as a biofuel. Define a biofuel.
Because it is produced from a biological source/biomass. Glucose is produced by plants and then fermented by bacteria to produce ethanol

e) It is known that a type of bacteria, *clostridium acetobutylcium,* converts cellulose to butanol. The following diagram represents a series of steps (which may involve multiple reactions) for the formation and combustion of the biofuels, ethanol and 1-butanol.



i. Which step represents photosynthesis?
Step 1
$6CO_2(g) + 6H_2O(l) \rightarrow C_6H_{12}O_6(aq) + 6O_2(g)$

ii. Which step represents fermentation?
Step 6
$C_6H_{12}O_6(aq) \rightarrow 2CH_3CH_2OH(aq) + 2CO_2(g)$