

Name of the Student: _____

Max. Marks : 17 Marks

Time : 17 Minutes

Q1.

Methanol can be regarded as a carbon-neutral fuel because it can be synthesised from carbon dioxide as shown in the equation below.



Standard enthalpy of formation and standard entropy data for the starting materials and products are shown in the following table.

	CO ₂ (g)	H ₂ (g)	CH ₃ OH(g)	H ₂ O(g)
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	-394	0	-201	-242
$S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$	214	131	238	189

- (a) Calculate the standard enthalpy change for this reaction.

(3)

- (b) Calculate the standard entropy change for this reaction.

- (c) Use your answers to parts (a) and (b) to explain why this reaction is **not** feasible at high temperatures.

Calculate the temperature at which the reaction becomes feasible.

Suggest why the industrial process is carried out at a higher temperature than you have calculated.

(If you have been unable to calculate values for ΔH and ΔS you may assume that they are -61 kJ mol^{-1} and $-205 \text{ J K}^{-1} \text{ mol}^{-1}$ respectively. These are **not** the correct values.)

[illegible]

(6)

- (d) Write an equation for the complete combustion of methanol. Use your equation to explain why the combustion reaction in the gas phase is feasible at all temperatures.

(4)

- (e) Give **one** reason why methanol, synthesised from carbon dioxide and hydrogen, may **not** be a carbon-neutral fuel.
