

Name of the Student: _____

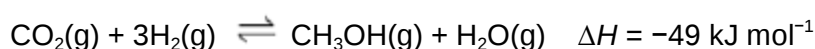
Max. Marks : 16 Marks

Time : 16 Minutes

Q1.

Many chemical processes release waste products into the atmosphere. Scientists are developing new solid catalysts to convert more efficiently these emissions into useful products, such as fuels. One example is a catalyst to convert these emissions into methanol. The catalyst is thought to work by breaking a H–H bond.

An equation for this formation of methanol is given below.



Some mean bond enthalpies are shown in the following table.

Bond	C=O	C–H	C–O	O–H
Mean bond enthalpy / kJ mol ⁻¹	743	412	360	463

- (a) Use the enthalpy change for the reaction and data from the table to calculate a value for the H–H bond enthalpy.

H–H bond enthalpy = _____ kJ mol⁻¹

(3)

- (b) A data book value for the H–H bond enthalpy is 436 kJ mol⁻¹.

Suggest **one** reason why this value is different from your answer to part (a).

(1)

- (c) Suggest **one** environmental advantage of manufacturing methanol fuel by this reaction.

(1)

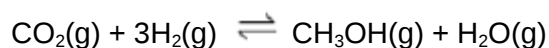
- (d) Use Le Chatelier's principle to justify why the reaction is carried out at a high pressure rather than at atmospheric pressure.

(3)

- (e) Suggest why the catalyst used in this process may become less efficient if the carbon dioxide and hydrogen contain impurities.

(1)

- (f) In a laboratory experiment to investigate the reaction shown in the equation below, 1.0 mol of carbon dioxide and 3.0 mol of hydrogen were sealed into a container. After the mixture had reached equilibrium, at a pressure of 500 kPa, the yield of methanol was 0.86 mol.



Calculate a value for K_p

Give your answer to the appropriate number of significant figures.

Give units with your answer.

$K_p =$ _____ Units = _____

(7)

(Total 16 marks)