

Name of the Student: _____

Max. Marks : 17 Marks

Time : 17 Minutes

Q1.

Ethanol is an important industrial compound.

- (a) Ethanol can be produced by the hydration of ethene.
The equation for the equilibrium that is established is



The operating conditions for the process are a temperature of 300 °C and a pressure of 7 MPa.
Under these conditions, the conversion of ethene into ethanol is 5%.

- (i) Identify the catalyst used in this process.
Deduce how an overall yield of 95% is achieved in this process without changing the operating conditions.

(2)

- (ii) Use your knowledge of equilibrium reactions to explain why a manufacturer might consider using an excess of steam in this process, under the same operating conditions.

(3)

- (iii) At pressures higher than 7 MPa, some of the ethene reacts to form a solid with a relative molecular mass greater than 5000.

Deduce the identity of this solid.

Give **one** other reason for **not** operating this process at pressures higher than 7 MPa.
Do **not** include safety reasons.

(2)

- (b) Write an equation for the reaction that has an enthalpy change that is the standard enthalpy of formation of ethanol.

(2)

- (c) When ethanol is used as a fuel, it undergoes combustion.

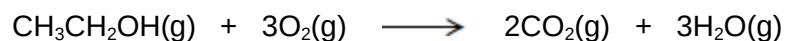
- (i) Define the term *standard enthalpy of combustion*.

(3)

- (ii) Consider these bond enthalpy data.

	C-H	C-C	C-O	O=O	C=O	O-H
Bond enthalpy / kJ mol⁻¹	412	348	360	496	805	463

Use these data and the equation to calculate a value for the enthalpy of combustion of gaseous ethanol.



(d) Gaseous ethanol can be used to convert hot copper(II) oxide into copper.

(i) Deduce the role of ethanol in this reaction.

(1)

(ii) Draw the structure of the organic compound with $M_r = 60$ that is produced in this reaction.

(1)

(Total 17 marks)