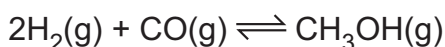


5 Methanol, CH₃OH, is manufactured by the reaction between hydrogen and carbon monoxide.

An equilibrium mixture is produced.



(a) State what happens to the concentration of CH₃OH when the reaction is at equilibrium.

Explain your answer in terms of rate of forward and reverse reactions.

.....
.....
..... [2]

(b) The reaction is carried out at a pressure of 75 atmospheres and a temperature of 250 °C.

(i) State **two** disadvantages of using a pressure **below** 75 atmospheres.

1
2 [2]

(ii) Complete Table 5.1 using **only** the words **increases**, **decreases** or **no change**.

Table 5.1

	effect on the concentration of CH ₃ OH(g) at equilibrium	effect on the rate of the reverse reaction
catalyst is added		

[2]

(iii) If a temperature of more than 250 °C is used, the yield of methanol decreases.

State what can be deduced about the forward reaction.

..... [1]

(iv) Suggest which of the elements from the list is a suitable catalyst for the reaction. Give a reason for your answer.

barium carbon copper potassium sulfur

catalyst

reason [2]

(c) Methanol is a member of the homologous series of alcohols.

(i) State **two** characteristics of all members of a homologous series.

1
2 [2]

(ii) State the molecular formula of an alcohol that contains five carbon atoms.

..... [1]

(d) Carboxylic acids react with alcohols to form esters.

(i) Draw the displayed formula of an ester which contains three carbon atoms.

[2]

(ii) Butyl ethanoate is an ester.

Name the alcohol and the carboxylic acid that react to produce butyl ethanoate.

alcohol

carboxylic acid [2]

(e) An organic compound has the following composition by mass:

C, 64.87%; H, 13.51%; O, 21.62%.

Calculate the empirical formula of the compound.

empirical formula = [2]

[Total: 18]