

Name of the Student: _____

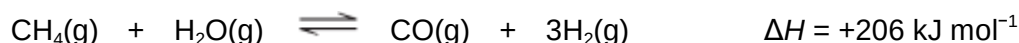
Max. Marks : 18 Marks

Time : 18 Minutes

Q1.

Hydrogen is produced in industry from methane and steam in a two-stage process.

- (a) In the first stage, carbon monoxide and hydrogen are formed.
The equation for this reaction is



- (i) Use Le Chatelier's principle to state whether a high or low temperature should be used to obtain the highest possible equilibrium yield of hydrogen from this first stage.
Explain your answer.

Temperature _____

Explanation _____

(3)

- (ii) Le Chatelier's principle suggests that a high pressure will produce a low yield of hydrogen in this first stage.

Explain, in terms of the behaviour of particles, why a high operating pressure is used in industry.

(2)

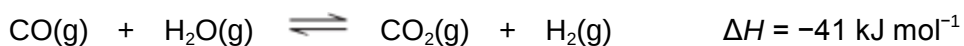
(iii) A nickel catalyst is used in the first stage.

Explain why the catalyst is more effective when coated onto an unreactive honeycomb.

(2)

- (b) The second stage is carried out in a separate reactor. Carbon monoxide is converted into carbon dioxide and more hydrogen is formed.

The equation for this reaction is



Use Le Chatelier's principle to state the effect, if any, of a **decrease** in the total pressure on the yield of hydrogen in this second stage. Explain your answer.

Effect _____

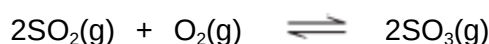
Explanation _____

(2)

(Total 9 marks)

Q2.

Sulfur dioxide reacts with oxygen to form sulfur trioxide according to the equation



- (a) Write an expression for the equilibrium constant, K_c , for this reaction and deduce its units.

K_c _____

Units _____

(2)

- (b) Samples of sulfur dioxide, oxygen and sulfur trioxide were added to a flask of volume 1.40 dm^3 and allowed to reach equilibrium at a given temperature.
The flask contained 0.0550 mol of sulfur dioxide and 0.0720 mol of sulfur trioxide at equilibrium.
 K_c has the numerical value of 27.9 under these conditions.

Calculate the amount, in moles, of oxygen gas in this equilibrium mixture.

(3)

- (c) The experiment in (b) was repeated with the same amounts of sulfur dioxide, oxygen and sulfur trioxide at the same temperature but in a smaller flask.
The mixture was allowed to reach equilibrium.

- (i) State the effect, if any, of using a smaller flask on the value of K_c

(1)

- (ii) State the effect, if any, of using a smaller flask on the amount of sulfur trioxide at equilibrium.
Explain your answer.

Effect _____

Explanation _____

(3)
(Total 9 marks)