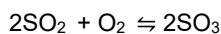


Equilibria (H)

1. The Contact process produces sulfur trioxide, SO_3 , in an **exothermic** reaction.



The temperature in the reaction vessel is usually $450\text{ }^\circ\text{C}$.

What happens as the temperature is increased to $600\text{ }^\circ\text{C}$?

- A Higher rate of reaction and increased yield of sulfur trioxide.
- B Higher rate of reaction and decreased yield of sulfur trioxide.
- C Higher rate of reaction and no change in yield of sulfur trioxide.
- D Lower rate of reaction and decreased yield of sulfur trioxide.

Your answer

[1]

2. Which statement describes what happens when a reaction **reaches** equilibrium?

- A The forward reaction happens at a faster rate than the backwards reaction.
- B The forward and backward reactions happen at the same rate.
- C The forward and backward reactions stop happening.
- D The backward reaction happens at a faster rate than the forward reaction.

Your answer

[1]

3 (a). In the Haber process nitrogen gas, N_2 , reacts with hydrogen gas.

Ammonia, NH_3 , is made. The reaction is a reversible reaction.

The conditions used to make ammonia in the Haber process are:

- a pressure of 200 atmospheres
- a temperature of $450\text{ }^\circ\text{C}$.

The reaction is an exothermic reaction.

A company making ammonia increases the temperature used to $550\text{ }^\circ\text{C}$.

- i. What happens to the **rate of the reaction** when the temperature is increased?

----- [1]

ii. The company thinks that the increase in temperature will increase the **yield** of ammonia.

Is the company correct? Explain your answer.

[2]

(b). The company wants to reduce the cost of making the ammonia.

They decide to reduce the pressure used to 150 atmospheres.

Write about **two** disadvantages of using a lower pressure to make ammonia.

1

2

[2]

4(a). The reversible reaction between carbon dioxide and hydrogen makes methane and water.



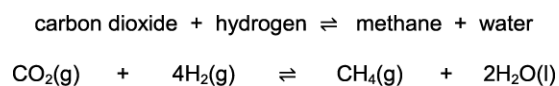
In a sealed container this reversible reaction forms a **dynamic equilibrium**.

What is meant by the term dynamic equilibrium?

Refer to both concentration and rate of reaction in your answer.

[2]

(b). * Kayvan investigates the effect of changing the pressure and changing the temperature on this reaction.



The table shows the percentage yield of methane in the equilibrium mixture under different conditions.

		Pressure in atmospheres			
		100	200	300	400
Temperature in °C	300	35%	52%	65%	80%
	600	30%	46%	58%	74%
	900	23%	37%	47%	62%
	1200	14%	25%	36%	48%

Kayvan predicts that the reaction between carbon dioxide and hydrogen is endothermic and involves a reduction in the volume of gases.

Describe and explain whether Kayvan's predictions are supported by the reaction and results in the table.

[6]

END OF QUESTION PAPER