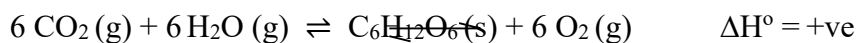


**2018 / 2019**

- 5 The equation of a simulated photosynthesis is represented by



At 31°C, the following equilibrium concentrations were found

$$[\text{H}_2\text{O}] = 7.91 \times 10^{-2} \text{ M}, [\text{CO}_2] = 9.30 \times 10^{-1} \text{ M}, [\text{O}_2] = 2.40 \times 10^{-3} \text{ M}.$$

- (b) Calculate the equilibrium constant,  $K_p$  for the reaction.
- (c) Determine the initial mass of  $\text{CO}_2$  involved in the above reaction.
- (d) Explain how the equilibrium position would be affected for each of the following changes:
  - i) water is added.
  - ii) temperature is increased.

[12 marks]

**2019 / 2020**

- 5 (a) Sulphur trioxide,  $\text{SO}_3$  gas decomposes sulphur dioxide and oxygen gas according to the following equation:

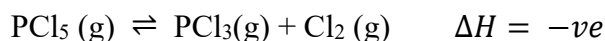


When 1.0 mol of  $\text{SO}_3$  is placed into a 2 L vessel and heated to 344 K, the system achieves equilibrium and 0.6 mol of  $\text{SO}_3$  gas is remained.

- i) Calculate the concentration of each gas at equilibrium.
- ii) Calculate the equilibrium constant,  $K_c$  at 344 K.

[7 marks]

- (b) Phosphorus pentachloride,  $\text{PCl}_5$  is left in a sealed container to establish equilibrium

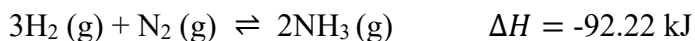


- i) Explain the effect of lowering temperature on the equilibrium constant,  $K_p$  of the system.
- ii) Explain the effect of adding argon gas at constant volume on the equilibrium position.

[4 marks]

2020 / 2021

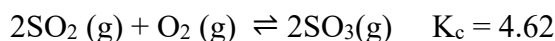
- 5 (a) Ammonia,  $\text{NH}_3$ , is produced at  $500^\circ\text{C}$  and 200 atm in the presence of  $\text{Fe}_2\text{O}_3$  catalyst according to the following equation:



Suggest **two (2) changes** that can be made to increase yield of  $\text{NH}_3$ . Explain your suggestions.

[4 marks]

- (b) Consider the following reaction:

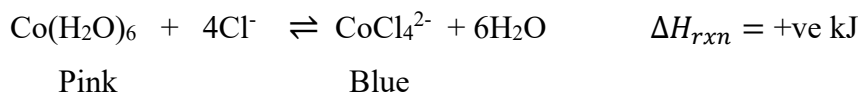


Determine the direction of the reaction if the concentrations of  $\text{SO}_2(\text{g})$ ,  $\text{SO}_3(\text{g})$  and  $\text{O}_2(\text{g})$  are 0.2 M, 0.15 M and  $8.55 \times 10^{-3}$  M, respectively.

[5 marks]

2021 / 2022

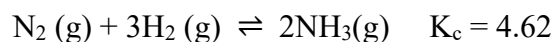
23. The following equilibrium is set up in a solution by dissolving cobalt (II) chloride crystal in water to form the pink coloration and followed by addition of concentrated hydrochloric acid until the solution becomes blue. Select the statement(s) that explain(s) the colour change observed upon cooling the reacted mixture.



- I Solution becomes blue
- II Solution becomes pink
- III Position of equilibrium shifts to the left to produce heat

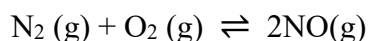
- A. I only
- B. I and II
- C. II and III
- D. I, II and III

24. A mixture of gas containing 0.174 mol N<sub>2</sub> and 0.441 mol H<sub>2</sub> is added to a 1.000L container, allowed to reach equilibrium as in the following equation:



At equilibrium, it is found that the concentration of NH<sub>3</sub> is 0.128 M. Calculate the value of K<sub>c</sub> for the reaction.

- A. 1.1
  - B. 1.7
  - C. 2.8
  - D. 9.6
25. The equilibrium constant for the reaction below is  $1.0 \times 10^{-5}$  at 1500K

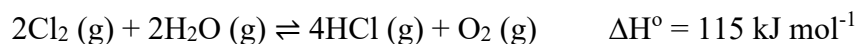


In an experiment, the concentrations of N<sub>2</sub>, O<sub>2</sub> and NO are 0.05 M, 0.02 M and 0.30 M respectively. Predict the direction of the reaction.

- A. Net reaction is to the right
- B. Net reaction is to the left
- C. Reaction lies in the middle
- D. Reaction is at equilibrium

**2022 / 2023**

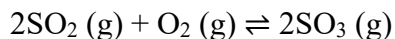
- 5 The equilibrium constant,  $K_p$ , for the reaction below is  $8.3 \times 10^{-3}$  at  $400^\circ\text{C}$ .



- (b) Calculate  $K_c$  for the reaction at  $400^\circ\text{C}$ . [4 marks]
- (c) Explain how the mass of HCl is affected by increasing the temperature. [2 marks]
- (d) Predict the direction of the net reaction if at one instant, the concentrations of  $\text{Cl}_2$ ,  $\text{H}_2\text{O}$ ,  $\text{HCl}$  and  $\text{O}_2$  measured are 0.70 M, 0.35 M, 0.25 M and 0.05 M respectively. [3 marks]

**2023 / 2024**

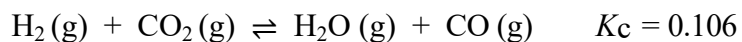
- 5 The second step in the contact process for producing sulphuric acid,  $\text{H}_2\text{SO}_4$ , involves the oxidation of sulphur dioxide gas,  $\text{SO}_2$  to generate sulphur trioxide gas,  $\text{SO}_3$ , as indicated by the reversible equation below.



- a) Sketch and label the graph to illustrate the change in concentration over time for  $\text{SO}_2$  gas and  $\text{SO}_3$  gas until equilibrium is achieved. [3 marks]
- b) Equilibrium is achieved when the partial pressure of  $\text{SO}_3$  gas is 0.364 atm and the total pressure is 0.658 atm at a temperature of  $500^\circ\text{C}$ . Determine the initial pressure of  $\text{SO}_2$  gas if the initial pressure of  $\text{O}_2$  gas is 0.250 atm. [5 marks]
- c) Predict the position of the equilibrium if 50% of  $\text{SO}_3$  gas is removed from the system. [1 mark]

**2024 / 2025**

- 5 (a) The water-gas shift reaction is important in several chemical processes, such as the production of  $\text{H}_2$  for fuel cells. The reaction can be written as follows:



A mixture of gases initially contains 0.025 M  $\text{H}_2$  and 0.015 M  $\text{CO}_2$  and is allowed to attain equilibrium at 700 K.

Determine the equilibrium concentrations of  $\text{H}_2$  and  $\text{CO}_2$ .

[4 marks]

- (b) A mixture consisting of 0.42 M of  $\text{N}_2$ , 0.20 M of  $\text{H}_2$  and 0.10 M of  $\text{NH}_3$  is placed in a vessel at certain temperature and pressure, and allowed to react based on the following equation:



- (i) Determine the direction of the net reaction under these conditions.
- (ii) Explain the effect on the equilibrium position when the volume of the vessel is decreased.

[5 marks]