AQA – Chemical equilibria, Le Chatelier's principle and Kc – A2 Chemistry P1

1. June/ 2020/Paper_1/No.6

| 0 | 6 |

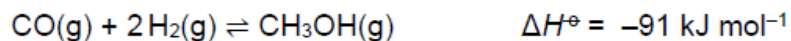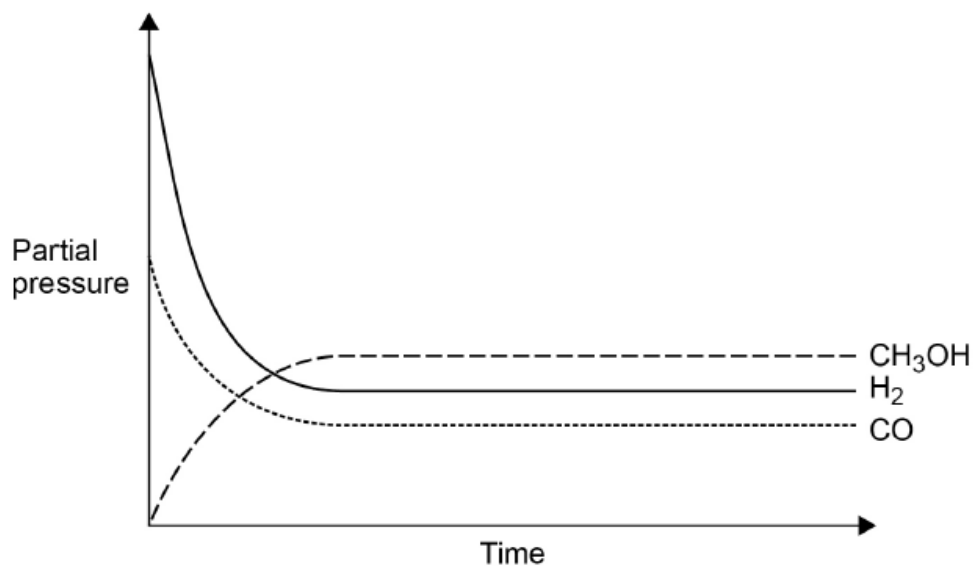Methanol can be manufactured in a reversible reaction as shown.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H^\ominus = -91 \text{ kJ mol}^{-1}$$

Figure 3 shows how the partial pressures change with time at a constant temperature.

Figure 3

| 0 | 6 |. | 1 |

Draw a cross (x) on the appropriate axis of **Figure 3** when the mixture reaches equilibrium.

[1 mark]

| 0 | 6 |. | 2 |

A 0.230 mol sample of carbon monoxide is mixed with hydrogen in a 1:2 mol ratio and allowed to reach equilibrium in a sealed flask at temperature T.
At equilibrium the mixture contains 0.120 mol of carbon monoxide.
The total pressure of this mixture is 1.04×10^4 kPa

Calculate the partial pressure, in kPa, of hydrogen in the equilibrium mixture.

[4 marks]

Partial pressure of hydrogen _____ kPa

| 0 | 6 |.| 3 | Give an expression for the equilibrium constant (K_p) for this reaction.

State the units.

[2 marks]

K_p

Units _____

2

0 6 . 4   Some more carbon monoxide is added to the mixture in Question 06.2. The new mixture is allowed to reach equilibrium at temperature T.

State the effect, if any, on the partial pressure of methanol and on the value of K_p

[2 marks]

Effect on partial pressure of methanol _____

Effect on value of K_p _____

0 6 . 5   State the effect, if any, of the addition of a catalyst on the value of K_p for this equilibrium.
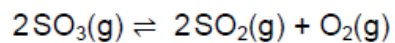Explain your answer.

[2 marks]

Effect on value of K_p _____

Explanation _____

_____

_____

2. June/ 2019/Paper_1/No.7

| 0 | 7 |

Sulfur trioxide decomposes on heating to form an equilibrium mixture containing sulfur dioxide and oxygen.

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$$

| 0 | 7 | . | 1 |

A sample of sulfur trioxide was heated and allowed to reach equilibrium at a given temperature.
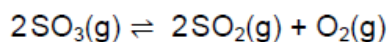The equilibrium mixture contained 6.08 g of sulfur dioxide.

Calculate the mass, in g, of oxygen gas in the equilibrium mixture.

[2 marks]

Mass _____ g

2. June/ 2019/Paper_1/No.7

0 7 . 2 A different mass of sulfur trioxide was heated and allowed to reach equilibrium at 1050 K

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$$

The amounts of each substance in the equilibrium mixture are shown in **Table 4**.

Table 4

Substance	Amount at equilibrium / mol
sulfur trioxide	0.320
sulfur dioxide	1.20
oxygen	0.600

For this reaction at 1050 K the equilibrium constant, $K_p = 7.62 \times 10^5$ Pa

Calculate the mole fraction of each substance at equilibrium.
Give the expression for the equilibrium constant, K_p
Calculate the total pressure, in Pa, of this equilibrium mixture.

[4 marks]

Mole fraction SO_3 _____

Mole fraction SO_2 _____

Mole fraction O_2 _____

K_p

Total pressure _____ Pa

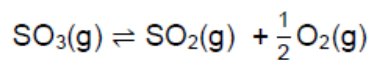| 0 | 7 |.| 3 | For this reaction at 1050 K the equilibrium constant, $K_p = 7.62 \times 10^5$ Pa
For this reaction at 500 K the equilibrium constant, $K_p = 3.94 \times 10^4$ Pa

Explain how this information can be used to deduce that the forward reaction is endothermic.

[2 marks]

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| 0 | 7 |.| 4 | Use data from Question **07.3** to calculate the value of K_p, at 500 K, for the equilibrium represented by this equation.
Deduce the units of K_p

$$SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$$

[2 marks]

K_p _____

Units _____

3. June/ 2021/Paper_1/No.4

0	4

This question is about iron and its ions.

0	4	.	1

Discuss the role of iron as a heterogeneous catalyst in the Haber process.

$$3H_2 + N_2 \rightleftharpoons 2NH_3$$

Your answer should include:

- the meaning of the term heterogeneous catalyst
- how iron acts as a heterogeneous catalyst
- the factors that affect the efficiency and lifetime of the catalyst.

[6 marks]

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3. June/ 2021/Paper_1/No.4

0 4 . 2 Fe^{2+} ions catalyse the reaction between peroxodisulfate(VI) ions and iodide ions in aqueous solution.

$$S_2O_8^{2-}(aq) + 2\,I^-(aq) \rightarrow 2\,SO_4^{2-}(aq) + I_2(aq)$$
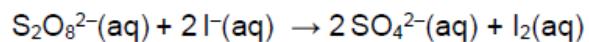
Explain why this reaction is slow before the catalyst is added.
Give **two** equations to show how Fe^{2+} ions catalyse this reaction.

[4 marks]

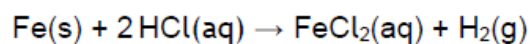Why reaction is slow before catalyst added _____

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_____

Equation 1

_____

Equation 2

_____

0 4 . 3 Give a reason why Zn^{2+} ions do **not** catalyse the reaction in Question 04.2.

[1 mark]

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0 4 . 4   Iron reacts with dilute hydrochloric acid to form iron(II) chloride and hydrogen.

$$Fe(s) + 2\,HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$$

A 0.998 g sample of pure iron is added to 30.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.

One of these reagents is in excess and the other reagent limits the amount of hydrogen produced in the reaction.

Calculate the maximum volume, in m^3, of hydrogen gas produced at 30 °C and 100 kPa.
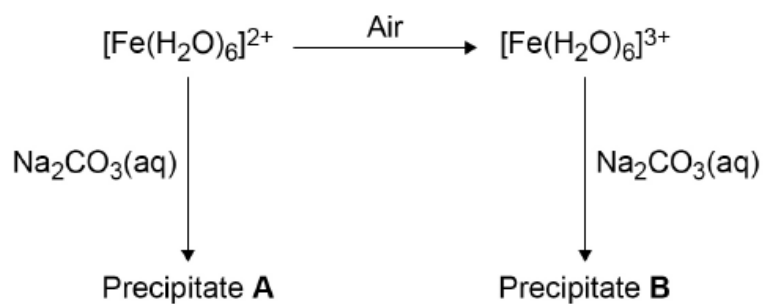
Give your answer to 3 significant figures.

In your answer you should identify the limiting reagent in the reaction.

The gas constant, $R = 8.31$ J K^{-1} mol^{-1}

[6 marks]

Figure 2 shows some reactions of iron ions in aqueous solution.

Figure 2

$[Fe(H_2O)_6]^{2+}$ $\xrightarrow{\text{Air}}$ $[Fe(H_2O)_6]^{3+}$

$Na_2CO_3(aq)$ $\qquad\qquad\qquad$ $Na_2CO_3(aq)$

Precipitate **A** $\qquad\qquad$ Precipitate **B**

| 0 | 4 | . | 5 |

Identify **A** and state its colour.

[2 marks]

Identity _____

Colour _____

| 0 | 4 | . | 6 |

Give the formula of **B** and state its colour.

Give an ionic equation for the reaction of $[Fe(H_2O)_6]^{3+}$ with aqueous Na_2CO_3 to form **B**.

[3 marks]

Formula _____

Colour _____

Ionic equation

_____

0 4 . 7 Explain why an aqueous solution containing $[Fe(H_2O)_6]^{3+}$ ions has a lower pH than an aqueous solution containing $[Fe(H_2O)_6]^{2+}$ ions.

[3 marks]

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