

AQA A-Level Chemistry

Chemical equilibria

Questions only

The newest questions, about an hour. All 40 are in the exam generator.

Questions

12

Total marks

46

Time allowed

1 h

Name

Class or teacher

Date

Instructions

- Answer all questions in the spaces provided.
- Use black ink. Show your working for every calculation.
- You may use a scientific calculator and the AQA Data Sheet.
- Print the separate mark scheme when you are ready to mark your answers.

For marking

Q	Source	Marks	Score
1	2024 AS P2 Q7	17	
2	2023 A-level P3 Q28	1	
3	2024 A-level P1 Q4	9	
4	2022 AS P2 Q20	1	
5	2022 AS P2 Q19	1	
6	2022 AS P2 Q18	1	
7	2023 A-level P3 Q13	1	
8	2023 AS P2 Q16	1	
9	2021 AS P2 Q20	1	
10	2025 AS P1 Q15	1	
11	2025 AS P1 Q7	11	
12	2023 A-level P3 Q25	1	

Total _____ / 46 Percentage _____ %

Questions from AQA past papers, 2021–2025, reproduced for revision. Practise these topics online, with instant marking:

whiteboardchemistry.com/revision/aqa-a-level-chemistry/exam-questions?topics=chemical-equilibria&len=0

Questions

Chemical equilibria · 12 questions · 46 marks · time allowed 1 h

Q1 · June 2024 · AS Paper 2 · Q7 · [17 marks]

This question also needs Halogenoalkanes.

This question is about propanoic acid ($\text{CH}_3\text{CH}_2\text{COOH}$).

The equation for the oxidation of propan-1-ol under reflux to form propanoic acid is shown.



(a) Acidified potassium dichromate(VI) is used as the oxidising agent.

State the colour change in this reaction.

[1 mark]

(b) A second organic product, X, is formed in small quantities.

The boiling point of X is 49°C

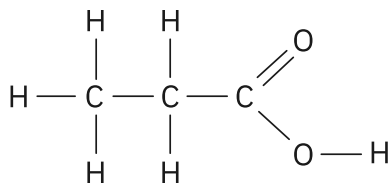
Identify X.

[1 mark]

(c) Propanoic acid molecules cannot be separated from the reaction mixture by simple distillation because propanoic acid forms hydrogen bonds with water molecules.

Complete the diagram to show how the propanoic acid molecule interacts with one water molecule through hydrogen bonding.

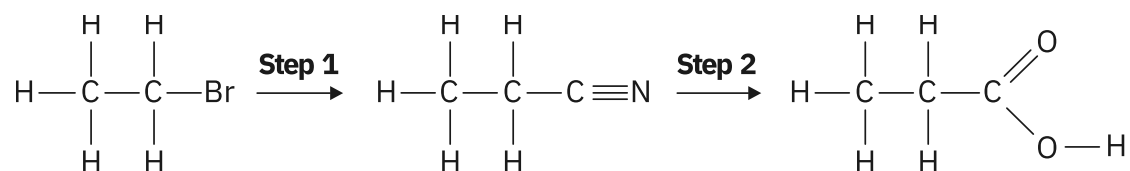
Include in the diagram all the partial charges and lone pairs of electrons involved in this hydrogen bond.



[3 marks]

Draw your answer on the figure above.

An alternative method of preparing propanoic acid is shown.



Step 1 involves the reaction of bromoethane with sodium cyanide under reflux in a suitable solvent.

(d) Name and outline the mechanism for Step 1.

[3 marks]

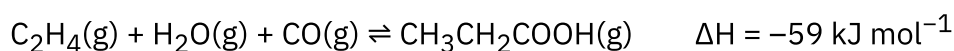
Name of mechanism

Outline of mechanism

(e) Suggest one reason why water is not a suitable solvent for Step 1.

[1 mark]

A third way of making propanoic acid uses the reaction between ethene, steam and carbon monoxide in the presence of a catalyst.



(f) Give an expression for the equilibrium constant (K_c) for this reaction.

$K_c =$

[1 mark]

(g) The table below shows the amount of each substance in an equilibrium mixture in a container of volume 1.20 dm^3 at a constant temperature.

Substance	$\text{C}_2\text{H}_4(\text{g})$	$\text{H}_2\text{O}(\text{g})$	$\text{CO}(\text{g})$	$\text{CH}_3\text{CH}_2\text{COOH}(\text{g})$
Amount of substance / mol	0.062	0.078	0.062	0.420

Calculate K_c

State the units.

[4 marks]

K_c

Units

(h) Predict the effect of increasing the temperature on the yield of propanoic acid.

Explain your answer.

[3 marks]

Effect on yield

Explanation

Q2 · June 2023 · Paper 3 · Q28 · [1 mark]

The equation for the complete combustion of butane is $\text{C}_4\text{H}_{10} + 6\frac{1}{2}\text{O}_2 \rightarrow 4\text{CO}_2 + 5\text{H}_2\text{O}$ What is the mole fraction of butane in a mixture of butane and oxygen with the minimum amount of oxygen needed for complete combustion?

Tick (✓) one box.

☐ **A** 0.133

☐ **B** 0.153

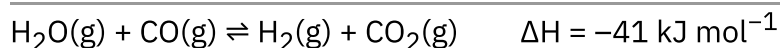
☐ **C** 0.167

☐ **D** 0.200

Q3 · June 2024 · Paper 1 · Q4 · [9 marks]

This question is about some gas mixtures at equilibrium.

This reaction can be used to make hydrogen.



(a) A mixture of 2.00 mol of $\text{H}_2\text{O}(\text{g})$ and 2.00 mol of $\text{CO}(\text{g})$ is allowed to reach equilibrium at a constant temperature in a 20 dm^3 container.

At equilibrium, there are 0.92 mol of $\text{H}_2(\text{g})$.

Calculate the mole fraction of $\text{H}_2(\text{g})$ in the equilibrium mixture.

Mole fraction of $\text{H}_2(\text{g})$

[2 marks]

(b) State why the equilibrium constant (K_p) for this reaction has no units.

[1 mark]

(c) The temperature of the equilibrium mixture formed in part (a) is increased.

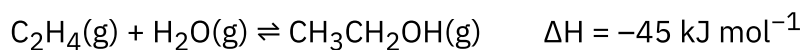
How does the amount of $\text{H}_2(\text{g})$ change when the new position of equilibrium is reached?

Tick (✓) one box.

The amount decreases.	☐
The amount does not change.	☐
The amount increases.	☐

[1 mark]

Ethanol can be made from ethene and steam.



The table below shows the mole fractions of each of the gases in an equilibrium mixture at 6000 kPa

Gas	Mole fraction
Ethene	0.645
Steam	0.323
Ethanol	0.0321

(d) Give an expression for K_p for this reaction.

Calculate the value of K_p at 6000 kPa

State the units.

[4 marks]

K_p

Units

(e) State the effect, if any, of an increase in volume of the container on the value of K_p for this reaction at a constant temperature.

[1 mark]

Q4 • June 2022 • AS Paper 2 • Q20 • [1 mark]

Methanol is made in this equilibrium reaction, using a catalyst. $\text{CO(g)} + 2 \text{H}_2\text{(g)} \rightleftharpoons \text{CH}_3\text{OH(g)}$ $\Delta H = -91 \text{ kJ mol}^{-1}$ Which change in condition will decrease the equilibrium yield of methanol?

Tick (✓) one box.

- ☐ A Increase the amount of CO in the equilibrium mixture.
- ☐ B Increase the pressure.
- ☐ C Increase the surface area of the catalyst.
- ☐ D Increase the temperature.

Q5 • June 2022 • AS Paper 2 • Q19 • [1 mark]

Methanol is made in this equilibrium reaction, using a catalyst. $\text{CO(g)} + 2 \text{H}_2\text{(g)} \rightleftharpoons \text{CH}_3\text{OH(g)}$ $\Delta H = -91 \text{ kJ mol}^{-1}$ 2.0 mol of carbon monoxide is mixed with 3.0 mol of hydrogen and allowed to reach equilibrium. The equilibrium mixture contains 0.6 mol of methanol. What is the total amount, in mol, of gas at equilibrium?

Tick (✓) one box.

- ☐ A 3.2
- ☐ B 3.8
- ☐ C 4.4
- ☐ D 5.0

Q6 • June 2022 • AS Paper 2 • Q18 • [1 mark]

Methanol is made in this equilibrium reaction, using a catalyst. $\text{CO(g)} + 2 \text{H}_2\text{(g)} \rightleftharpoons \text{CH}_3\text{OH(g)}$ $\Delta H = -91 \text{ kJ mol}^{-1}$ The reaction reaches equilibrium in a container of fixed volume. Which is the expression for K_c for this equilibrium?

Tick (✓) one box.

☐ **A** $K_c = [\text{CH}_3\text{OH}] / ([\text{CO}] + [\text{H}_2]^2)$

☐ **B** $K_c = [\text{CH}_3\text{OH}] / ([\text{CO}] [\text{H}_2]^2)$

☐ **C** $K_c = ([\text{CO}] + [\text{H}_2]^2) / [\text{CH}_3\text{OH}]$

☐ **D** $K_c = ([\text{CO}] [\text{H}_2]^2) / [\text{CH}_3\text{OH}]$

Q7 • June 2023 • Paper 3 • Q13 • [1 mark]

When HF is added to water at 298 K, this equilibrium is established. $\text{HF(aq)} \rightleftharpoons \text{H}^+\text{(aq)} + \text{F}^-\text{(aq)}$ At equilibrium, $[\text{HF}] = 7.70 \times 10^{-3} \text{ mol dm}^{-3}$ and $[\text{F}^-] = 2.30 \times 10^{-3} \text{ mol dm}^{-3}$ What is the value of the equilibrium constant, in mol dm^{-3} , at 298 K?

Tick (✓) one box.

☐ **A** 1.45×10^3

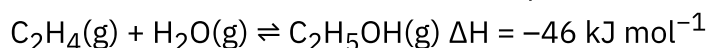
☐ **B** 3.35

☐ **C** 2.99×10^{-1}

☐ **D** 6.87×10^{-4}

Q8 • June 2023 • AS Paper 2 • Q16 • [1 mark]

Which statement about the industrial production of ethanol from ethene at 300 °C is correct?



Tick (✓) one box.

☐ **A** An increase in pressure decreases the equilibrium yield of ethanol.

☐ **B** An increase in pressure increases the value of K_c

☐ **C** An increase in temperature increases the equilibrium yield of ethanol.

☐ **D** An increase in temperature decreases the value of K_c

Q9 • November 2021 • AS Paper 2 • Q20 • [1 mark]

Which statement about the use of a catalyst in a reversible reaction is correct?

Tick (✓) one box.

- ☐ **A** The activation energy for the reverse reaction is increased.
- ☐ **B** The equilibrium constant increases.
- ☐ **C** The rate of the reverse reaction increases.
- ☐ **D** The enthalpy change for the forward reaction decreases.
-

Q10 • June 2025 • AS Paper 1 • Q15 • [1 mark]

Which equilibrium has a lower yield of product when the pressure in the system is increased at constant temperature?

Tick (✓) one box.

- ☐ **A** $2\text{NOCl(g)} \rightleftharpoons 2\text{NO(g)} + \text{Cl}_2\text{(g)}$
- ☐ **B** $2\text{SO}_2\text{(g)} + \text{O}_2\text{(g)} \rightleftharpoons 2\text{SO}_3\text{(g)}$
- ☐ **C** $\text{I}_2\text{(g)} + \text{H}_2\text{(g)} \rightleftharpoons 2\text{HI(g)}$
- ☐ **D** $\text{N}_2\text{(g)} + 3\text{H}_2\text{(g)} \rightleftharpoons 2\text{NH}_3\text{(g)}$
-

Q11 • June 2025 • AS Paper 1 • Q7 • [11 marks]

This question is about chemical equilibria.

A mixture of hydrogen and iodine is allowed to reach equilibrium in a sealed container.

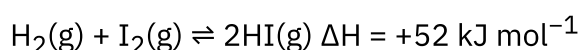
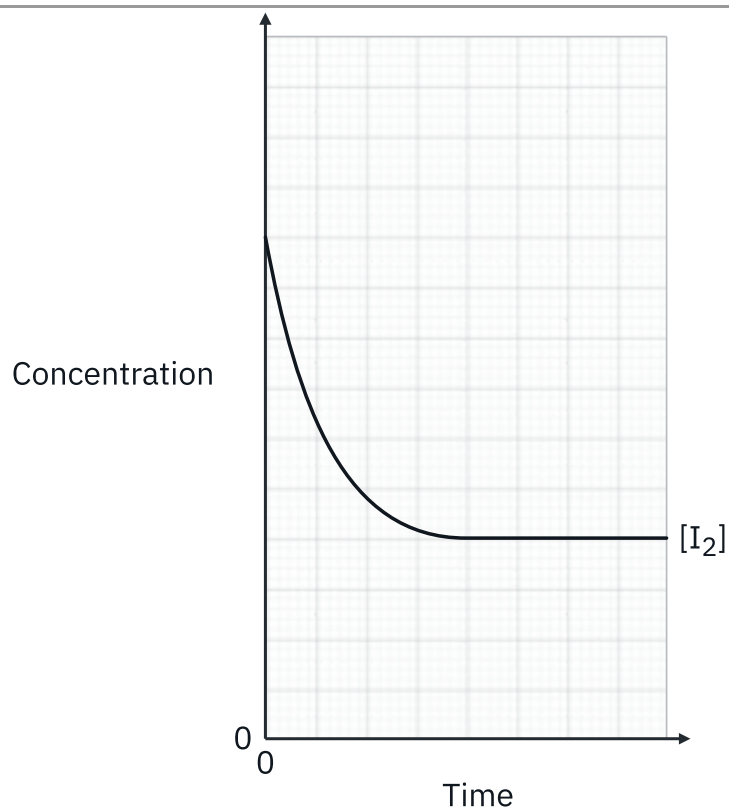


Figure 1 shows how the concentration of iodine changes with time.

Figure 1



07.1 Draw a line on Figure 1 to show how the concentration of hydrogen iodide changes with time.

[2 marks]

Draw your answer on the figure above.

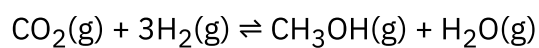
07.2 State and explain the effect of increasing the temperature on the equilibrium yield of hydrogen iodide.

[3 marks]

Effect on yield

Explanation

Carbon dioxide can react with hydrogen to form methanol.



2.50 mol of CO_2 are mixed with 6.00 mol of H_2 in a sealed container with a volume of 4.60 dm^3

The mixture is left to reach equilibrium at a fixed temperature.

At equilibrium, 1.30 mol of CO_2 remain.

07.3 Give an expression for the equilibrium constant, K_c , for this reaction.

Calculate a value for the equilibrium constant at this fixed temperature.

Give the units of the equilibrium constant.

[6 marks]

Expression for K_c

Calculation

K_c Units

Q12 · June 2023 · Paper 3 · Q25 · [1 mark]

Which statement about catalysts used in reactions at equilibrium, at a constant temperature, is correct?

Tick (✓) one box.

- ☐ **A** They are always used in the solid state.
- ☐ **B** They increase the rate of the forward reaction but decrease the rate of the reverse reaction.
- ☐ **C** They have no effect on the value of the equilibrium constant.
- ☐ **D** They make the forward reaction more exothermic.

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Mark scheme:

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