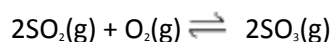


Q1. Which change would alter the value of the equilibrium constant (K_p) for this reaction?



- A Increasing the total pressure of the system.
- B Increasing the concentration of sulfur trioxide.
- C Increasing the concentration of sulfur dioxide.
- D Increasing the temperature.

(Total 1 mark)

Q2. This question is about the reaction given below.



Enthalpy data for the reacting species are given in the table below.

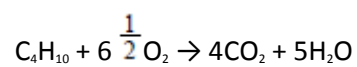
Substance	CO(g)	H ₂ O(g)	CO ₂ (g)	H ₂ (g)
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	-110	-242	-394	0

Which one of the following statements is **not** correct?

- A The value of K_p changes when the temperature changes.
- B The activation energy decreases when the temperature is increased.
- C The entropy change is more positive when the water is liquid rather than gaseous.
- D The enthalpy change is more positive when the water is liquid rather than gaseous.

(Total 1 mark)

Q3.The equation for the combustion of butane in oxygen is

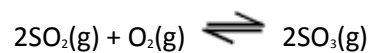


The mole fraction of butane in a mixture of butane and oxygen with the minimum amount of oxygen required for complete combustion is

- A** 0.133
- B** 0.153
- C** 0.167
- C** 0.200

(Total 1 mark)

Q4. This question relates to the equilibrium gas-phase synthesis of sulphur trioxide:



Thermodynamic data for the components of this equilibrium are:

Substance	$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	$S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$
$\text{SO}_3(\text{g})$	-396	+257
$\text{SO}_2(\text{g})$	-297	+248
$\text{O}_2(\text{g})$	0	+204

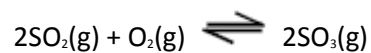
This equilibrium, at a temperature of 585 K and a total pressure of 540 kPa, occurs in a vessel of volume 1.80 dm³. At equilibrium, the vessel contains 0.0500 mol of $\text{SO}_2(\text{g})$, 0.0800 mol of $\text{O}_2(\text{g})$ and 0.0700 mol of $\text{SO}_3(\text{g})$.

The mole fraction of SO_3 in the equilibrium mixture is

- A 0.250
- B 0.350
- C 0.440
- D 0.700

(Total 1 mark)

Q5. This question relates to the equilibrium gas-phase synthesis of sulphur trioxide:



Thermodynamic data for the components of this equilibrium are:

Substance	$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	$S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$
$\text{SO}_3(\text{g})$	-396	+257
$\text{SO}_2(\text{g})$	-297	+248
$\text{O}_2(\text{g})$	0	+204

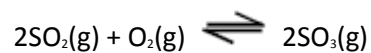
This equilibrium, at a temperature of 585 K and a total pressure of 540 kPa, occurs in a vessel of volume 1.80 dm³. At equilibrium, the vessel contains 0.0500 mol of $\text{SO}_2(\text{g})$, 0.0800 mol of $\text{O}_2(\text{g})$ and 0.0700 mol of $\text{SO}_3(\text{g})$.

With pressures expressed in MPa units, the value of the equilibrium constant, K_p , is

- A 4.90
- B 6.48
- C 9.07
- D 16.8

(Total 1 mark)

Q6. This question relates to the equilibrium gas-phase synthesis of sulphur trioxide:



Thermodynamic data for the components of this equilibrium are:

Substance	$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	$S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$
$\text{SO}_3(\text{g})$	-396	+257
$\text{SO}_2(\text{g})$	-297	+248
$\text{O}_2(\text{g})$	0	+204

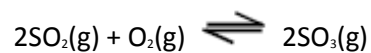
This equilibrium, at a temperature of 585 K and a total pressure of 540 kPa, occurs in a vessel of volume 1.80 dm³. At equilibrium, the vessel contains 0.0500 mol of $\text{SO}_2(\text{g})$, 0.0800 mol of $\text{O}_2(\text{g})$ and 0.0700 mol of $\text{SO}_3(\text{g})$.

Possible units for the equilibrium constant K_p include

- A no units
- B kPa
- C Mpa^{-1}
- D kPa^{-2}

(Total 1 mark)

Q7. This question relates to the equilibrium gas-phase synthesis of sulphur trioxide:



Thermodynamic data for the components of this equilibrium are:

Substance	$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	$S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$
$\text{SO}_3(\text{g})$	-396	+257
$\text{SO}_2(\text{g})$	-297	+248
$\text{O}_2(\text{g})$	0	+204

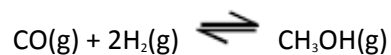
This equilibrium, at a temperature of 585 K and a total pressure of 540 kPa, occurs in a vessel of volume 1.80 dm³. At equilibrium, the vessel contains 0.0500 mol of $\text{SO}_2(\text{g})$, 0.0800 mol of $\text{O}_2(\text{g})$ and 0.0700 mol of $\text{SO}_3(\text{g})$.

At equilibrium in the same vessel of volume 1.80 dm³ under altered conditions, the reaction mixture contains 0.0700 mol of $\text{SO}_3(\text{g})$, 0.0500 mol of $\text{SO}_2(\text{g})$ and 0.0900 mol of $\text{O}_2(\text{g})$ at a total pressure of 623 kPa. The temperature in the equilibrium vessel is

- A 307 °C
- B 596 K
- C 337 °C
- D 642 K

(Total 1 mark)

Q8. The following information concerns the equilibrium gas-phase synthesis of methanol.



At equilibrium, when the temperature is 68 °C, the total pressure is 1.70 MPa.
The number of moles of CO, H₂ and CH₃OH present are 0.160, 0.320 and 0.180, respectively.

Thermodynamic data are given below.

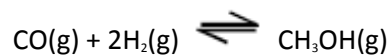
Substance	$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	$S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$
CO(g)	-110	198
H ₂ (g)	0	131
CH ₃ OH(g)	-201	240

Possible units for the equilibrium constant, K_p , for this reaction are

- A no units
- B kPa
- C MPa⁻¹
- D kPa⁻²

(Total 1 mark)

Q9. The following information concerns the equilibrium gas-phase synthesis of methanol.



At equilibrium, when the temperature is 68 °C, the total pressure is 1.70 MPa.
The number of moles of CO, H₂ and CH₃OH present are 0.160, 0.320 and 0.180, respectively.

Thermodynamic data are given below.

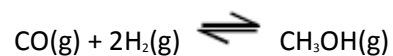
Substance	$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	$S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$
CO(g)	-110	198
H ₂ (g)	0	131
CH ₃ OH(g)	-201	240

The mole fraction of hydrogen in the equilibrium mixture is

- A 0.242
- B 0.485
- C 0.653
- D 0.970

(Total 1 mark)

Q10. The following information concerns the equilibrium gas-phase synthesis of methanol.



At equilibrium, when the temperature is 68 °C, the total pressure is 1.70 MPa.
The number of moles of CO, H₂ and CH₃OH present are 0.160, 0.320 and 0.180, respectively.

Thermodynamic data are given below.

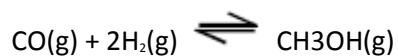
Substance	ΔH_f^\ominus / kJ mol ⁻¹	S^\ominus / J K ⁻¹ mol ⁻¹
CO(g)	-110	198
H ₂ (g)	0	131
CH ₃ OH(g)	-201	240

With pressures expressed in MPa units, the value of the equilibrium constant, K_p , under these conditions is

- A 1.37
- B 1.66
- C 2.82
- D 4.80

(Total 1 mark)

Q11. The following information concerns the equilibrium gas-phase synthesis of methanol.



At equilibrium, when the temperature is 68 °C, the total pressure is 1.70 MPa.

The number of moles of CO, H₂ and CH₃OH present are 0.160, 0.320 and 0.180, respectively.

Thermodynamic data are given below.

Substance	ΔH_f^\ominus / kJ mol ⁻¹	S^\ominus / J K ⁻¹ mol ⁻¹
CO(g)	-110	198
H ₂ (g)	0	131
CH ₃ OH(g)	-201	240

Which one of the following statements applies to this equilibrium?

- A The value of K_p increases if the temperature is raised.
- B The value of K_p increases if the pressure is raised.
- C The yield of methanol decreases if the temperature is lowered.
- D The yield of methanol decreases if the pressure is lowered.

(Total 1 mark)