Access Tuition

A-Level Chemistry

Kp (Multiple Choice)

Question Paper

Time available: 16 minutes
Marks available: 15 marks

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1. The equation for the reaction between sulfur dioxide and oxygen is shown.

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

In an experiment, 2.00 mol of sulfur dioxide are mixed with 2.00 mol of oxygen.

The total amount of the three gases at equilibrium is 3.40 mol

What is the mole fraction of sulfur trioxide in the equilibrium mixture?

A 0.176 ⬭

B 0.353 ⬭

C 0.600 ⬭

D 1.200 ⬭

(Total 1 mark)

2. Nitrogen reacts with hydrogen in this exothermic reaction

$$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$$

Which change increases the equilibrium yield of ammonia but has no effect on the value of the equilibrium constant K_p?

A Add a catalyst ⬭

B Increase the partial pressure of nitrogen ⬭

C Decrease the temperature ⬭

D Decrease the total pressure ⬭

(Total 1 mark)

3. An equilibrium mixture is prepared in a container of fixed volume.

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g) \qquad \Delta H = -108 \text{ kJ mol}^{-1}$$

The temperature of this mixture is decreased and the mixture is allowed to reach a new equilibrium.

Which is greater for the new equilibrium than for the original equilibrium?

A The mole fraction of carbon monoxide ○

B The partial pressure of chlorine ○

C The total pressure of the mixture ○

D The value of the equilibrium constant, K_p ○

(Total 1 mark)

4. Which statement about K_p is correct for this reaction in the gas phase?

$$W + X + Y_2 \rightleftharpoons WXY + Y \qquad \Delta H = -46 \text{ kJ mol}^{-1}$$

A The value of K_p is independent of pressure. ○

B The value of K_p increases as pressure increases. ○

C The value of K_p increases as temperature increases. ○

D The value of K_p is independent of temperature. ○

(Total 1 mark)

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

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

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)

6. This question is about the reaction given below.

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

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

Substance	CO(g)	$H_2O(g)$	$CO_2(g)$	$H_2(g)$
$\Delta H_r^{\ominus}$ / 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)

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

$$C_4H_{10} + 6\frac{1}{2}O_2 \rightarrow 4CO_2 + 5H_2O$$

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)

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

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

Thermodynamic data for the components of this equilibrium are:

Substance	**$\Delta H_f^{\ominus}$ / kJ mol^{-1}**	**$S^{\ominus}$ / J K^{-1} mol^{-1}**
$SO_3(g)$	−396	+257
$SO_2(g)$	–297	+248
$O_2(g)$	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 dm^3. At equilibrium, the vessel contains 0.0500 mol of $SO_2(g)$, 0.0800 mol of $O_2(g)$ and 0.0700 mol of $SO_3(g)$.

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)

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

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

Thermodynamic data for the components of this equilibrium are:

Substance	$\Delta H_f^{\ominus}$ **/ kJ mol^{-1}**	$S^{\ominus}$ **/ J K^{-1} mol^{-1}**
$SO_3(g)$	−396	+257
$SO_2(g)$	–297	+248
$O_2(g)$	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 dm^3. At equilibrium, the vessel contains 0.0500 mol of $SO_2(g)$, 0.0800 mol of $O_2(g)$ and 0.0700 mol of $SO_3(g)$.

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)

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

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

Thermodynamic data for the components of this equilibrium are:

Substance	**$\Delta H_f^{\ominus}$ / kJ mol^{-1}**	**$S^{\ominus}$ / J K^{-1} mol^{-1}**
$SO_3(g)$	−396	+257
$SO_2(g)$	–297	+248
$O_2(g)$	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 dm^3. At equilibrium, the vessel contains 0.0500 mol of $SO_2(g)$, 0.0800 mol of $O_2(g)$ and 0.0700 mol of $SO_3(g)$.

Possible units for the equilibrium constant K_p include

A no units

B kPa

C Mpa^{-1}

D kPa^{-2}

(Total 1 mark)

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

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

Thermodynamic data for the components of this equilibrium are:

Substance	**$\Delta H_f^{\ominus}$ / kJ mol^{-1}**	**$S^{\ominus}$ / J K^{-1} mol^{-1}**
$SO_3(g)$	−396	+257
$SO_2(g)$	–297	+248
$O_2(g)$	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 dm^3. At equilibrium, the vessel contains 0.0500 mol of $SO_2(g)$, 0.0800 mol of $O_2(g)$ and 0.0700 mol of $SO_3(g)$.

At equilibrium in the same vessel of volume 1.80 dm^3 under altered conditions, the reaction mixture contains 0.0700 mol of $SO_3(g)$, 0.0500 mol of $SO_2(g)$ and 0.0900 mol of $O_2(g)$ 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)

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

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

At equilibrium, when the temperature is 68 °C, the total pressure is 1.70 MPa.
The number of moles of CO, H_2 and CH_3OH present are 0.160, 0.320 and 0.180, respectively.

Thermodynamic data are given below.

Substance	**$\Delta H_f^{\ominus}$ / kJ mol^{-1}**	**$S^{\ominus}$ / J K^{-1} mol^{-1}**
CO(g)	−110	198
H_2(g)	0	131
CH_3OH(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)

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

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

At equilibrium, when the temperature is 68 °C, the total pressure is 1.70 MPa.
The number of moles of CO, H_2 and CH_3OH present are 0.160, 0.320 and 0.180, respectively.

Thermodynamic data are given below.

Substance	**$\Delta H_f^\ominus$ / kJ mol^{-1}**	**$S^\ominus$ / J K^{-1} mol^{-1}**
CO(g)	−110	198
H_2(g)	0	131
CH_3OH(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)

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

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

At equilibrium, when the temperature is 68 °C, the total pressure is 1.70 MPa.
The number of moles of CO, H_2 and CH_3OH present are 0.160, 0.320 and 0.180, respectively.

Thermodynamic data are given below.

Substance	**$\Delta H_f^\ominus$ / kJ mol^{-1}**	**$S^\ominus$ / J K^{-1} mol^{-1}**
CO(g)	−110	198
H_2(g)	0	131
CH_3OH(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)

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

$$CO(g) + 2H_2(g) \rightleftharpoons CH3OH(g)$$

At equilibrium, when the temperature is 68 °C, the total pressure is 1.70 MPa.
The number of moles of CO, H_2 and CH_3OH present are 0.160, 0.320 and 0.180, respectively.

Thermodynamic data are given below.

Substance	**$\Delta H_f^\ominus$ / kJ mol^{-1}**	**$S^\ominus$ / J K^{-1} mol^{-1}**
CO(g)	−110	198
H_2(g)	0	131
CH_3OH(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)