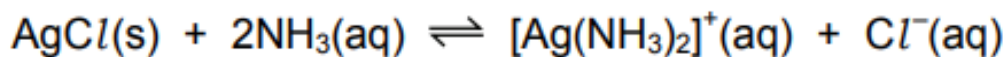


### Chemical Equilibrium Multiple Choice Questions

1) The equation for the reaction between silver chloride and aqueous ammonia is shown.

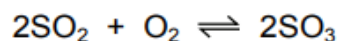


What are the units of  $K_c$  for this reaction?

- A no units  
B  $\text{mol}^{-1} \text{dm}^3$   
C  $\text{mol dm}^{-3}$   
D  $\text{mol}^2 \text{dm}^{-6}$

2)

The main stage in the Contact process is an equilibrium reaction.

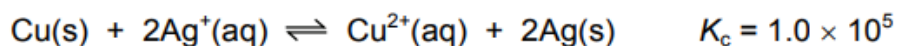


Which row describes the effect of the named condition on the equilibrium yield?

	presence of catalyst	high pressure	high temperature
A	no effect on yield	decreases yield	increases yield
B	no effect on yield	increases yield	decreases yield
C	increases yield	decreases yield	increases yield
D	increases yield	increases yield	decreases yield

3)

When copper is added to a solution of silver ions, the following equilibrium is established.



What is the concentration of silver ions at equilibrium when  $[\text{Cu}^{2+}] = 0.10 \text{ mol dm}^{-3}$ ?

- A  $5.0 \times 10^{-7} \text{ mol dm}^{-3}$   
B  $5.0 \times 10^{-4} \text{ mol dm}^{-3}$   
C  $1.0 \times 10^{-3} \text{ mol dm}^{-3}$   
D  $1.0 \times 10^2 \text{ mol dm}^{-3}$

- 4) The reaction between sulfur dioxide and oxygen is reversible.



Which conditions of pressure and temperature favour the **reverse** reaction?

	pressure	temperature
<b>A</b>	high	high
<b>B</b>	high	low
<b>C</b>	low	high
<b>D</b>	low	low

- 5) Which statement about the effect of a catalyst on a reversible reaction is correct?

- A The activation energy of the forward reaction stays the same.
- B The composition of the equilibrium mixture stays the same.
- C The rate of the backward reaction stays the same.
- D The value of the equilibrium constant changes.

6)

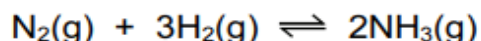
Two moles of compound P were placed in a sealed container. The container was heated and P was partially decomposed to produce Q and R only. A dynamic equilibrium between P, Q and R was established.

At equilibrium  $x$  moles of R were present and the total number of moles present was  $\left(2 + \frac{x}{2}\right)$ .

What is the equation for this reversible reaction?

- A  $\text{P} \rightleftharpoons 2\text{Q} + \text{R}$
- B  $2\text{P} \rightleftharpoons 2\text{Q} + \text{R}$
- C  $2\text{P} \rightleftharpoons \text{Q} + \text{R}$
- D  $2\text{P} \rightleftharpoons \text{Q} + 2\text{R}$

- 7) Ammonia is manufactured from nitrogen and hydrogen using the Haber process.



What is the expression for  $K_c$  for this equilibrium?

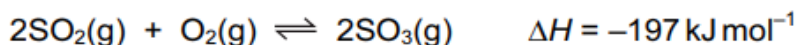
- A**  $\frac{2[\text{NH}_3(\text{g})]}{[\text{N}_2(\text{g})] + 3[\text{H}_2(\text{g})]}$
- B**  $\frac{2[\text{NH}_3(\text{g})]}{[\text{N}_2(\text{g})] \times 3[\text{H}_2(\text{g})]}$
- C**  $\frac{[\text{NH}_3(\text{g})]^2}{[\text{N}_2(\text{g})] + [\text{H}_2(\text{g})]^3}$
- D**  $\frac{[\text{NH}_3(\text{g})]^2}{[\text{N}_2(\text{g})] \times [\text{H}_2(\text{g})]^3}$

- 8) The responses **A** to **D** should be selected on the basis of

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>1, 2 and 3</b> are correct	<b>1 and 2</b> only are correct	<b>2 and 3</b> only are correct	<b>1 only</b> is correct

No other combination of statements is used as a correct response.

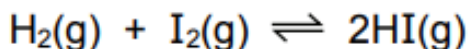
Sulfur dioxide and oxygen react in the gas phase.



Which statements are correct?

- 1 Increasing the pressure increases the equilibrium yield of  $\text{SO}_3$ .
- 2 Increasing the temperature lowers the value of the equilibrium constant  $K_p$ .
- 3 The presence of a vanadium(V) oxide catalyst increases the equilibrium yield of  $\text{SO}_3$ .

9) In an experiment, 2.00 mol of hydrogen and 3.00 mol of iodine were heated together in a sealed container and allowed to reach equilibrium at a fixed temperature. The container had a fixed volume of 1.00 dm<sup>3</sup>. At equilibrium, there were 2.40 mol of iodine present in the mixture.



What is the value of the equilibrium constant,  $K_c$ ?

**A** 0.107 **B** 0.357

**C** 0.429 **D** 2.33

10) The responses **A** to **D** should be selected on the basis of

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>1, 2 and 3</b> are correct	<b>1 and 2</b> only are correct	<b>2 and 3</b> only are correct	<b>1 only</b> is correct

No other combination of statements is used as a correct response.

Which statements about reversible reactions are correct?

- 1 An increase in concentration of a reactant always increases the concentration of the product.
- 2 An increase in temperature always increases the rate at which the equilibrium is established.
- 3 An increase in temperature always increases the concentration of the product at equilibrium.

11)

The reaction between sulfur dioxide and oxygen is reversible.



In an equilibrium mixture at 1000 K the sulfur dioxide concentration is 0.200 mol dm<sup>-3</sup> and the oxygen concentration is 0.100 mol dm<sup>-3</sup>.

What is the sulfur trioxide concentration?

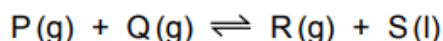
- A** 1.058 mol dm<sup>-3</sup>
- B** 1.120 mol dm<sup>-3</sup>
- C** 2.366 mol dm<sup>-3</sup>
- D** 5.600 mol dm<sup>-3</sup>

12) The responses **A** to **D** should be selected on the basis of

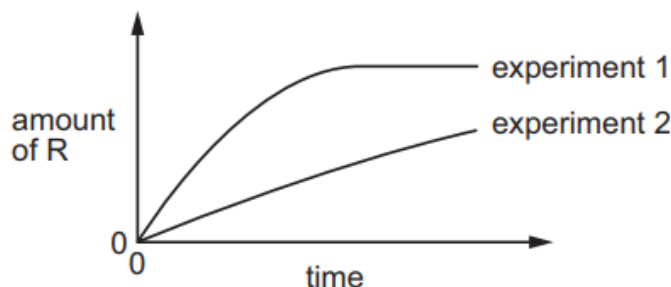
<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

No other combination of statements is used as a correct response.

The stoichiometry of a catalysed reaction is shown by the equation below.



Two experiments are carried out in which the amount of R is measured. The results are shown in the diagram.



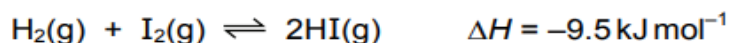
Which changes in the conditions could explain the results shown?

- 1 A lower pressure was used in experiment 2.
- 2 A different catalyst was used in experiment 2.
- 3 Product S was continuously removed from the reaction vessel in experiment 2.

13)

In this question you should assume that all gases behave ideally.

Hydrogen and iodine react reversibly in the following reaction. The system reaches dynamic equilibrium.

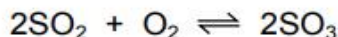


Which statement **must** be true for the  $K_p$  of this equilibrium to be constant?

- A The partial pressures of  $\text{H}_2$ ,  $\text{I}_2$  and  $\text{HI}$  are equal.
- B The external pressure is constant.
- C The forward and reverse reactions have stopped.
- D The temperature is constant.

14)

0.200 mol of sulfur dioxide and 0.200 mol of oxygen are placed in a 1.00 dm<sup>3</sup> sealed container. The gases are allowed to react until equilibrium is reached.

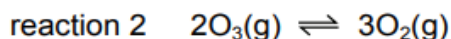
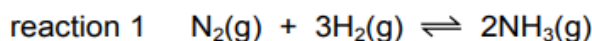


At equilibrium there is 0.100 mol of SO<sub>3</sub> in the container.

What is the value of  $K_c$ ?

- A 0.150 mol dm<sup>-3</sup>
- B 0.800 mol dm<sup>-3</sup>
- C 1.25 mol<sup>-1</sup> dm<sup>3</sup>
- D 6.67 mol<sup>-1</sup> dm<sup>3</sup>

15) Two reactions are shown.



In reaction 1, a finely powdered iron catalyst is used.

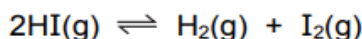
In reaction 2, a vaporised tetrachloromethane catalyst in ultraviolet light is used.

Which statement about the catalysts used is correct?

- A Both reaction 1 and reaction 2 use a heterogeneous catalyst.
- B Both reaction 1 and reaction 2 use a homogeneous catalyst.
- C Reaction 1 uses a heterogeneous catalyst and reaction 2 uses a homogeneous catalyst.
- D Reaction 1 uses a homogeneous catalyst and reaction 2 uses a heterogeneous catalyst.

16)

Hydrogen iodide dissociates into hydrogen and iodine.



In an experiment,  $b$  mol of hydrogen iodide were put into a sealed vessel at pressure  $p$ . At equilibrium,  $x$  mol of the hydrogen iodide had dissociated.

Which expression for  $K_p$  is correct?

- A  $\frac{x^2}{(b-x)^2}$
- B  $\frac{x^2 p^2}{(b-x)^2}$
- C  $\frac{x^2 p^2}{4b(b-x)}$
- D  $\frac{x^2}{4(b-x)^2}$

17)

An important reaction in the manufacture of nitric acid is the catalytic oxidation of ammonia.



For every mole of  $\text{O}_2$  that reacts in this way, 181.8 kJ of energy are released.

A factory makes  $2.50 \times 10^5$  mol of NO every day.

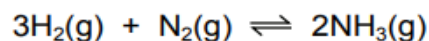
How much energy, in kJ, is released every day?

- A**  $3.64 \times 10^7$       **B**  $4.55 \times 10^7$       **C**  $5.68 \times 10^7$       **D**  $2.27 \times 10^8$

18)

The table shows the partial pressures in an equilibrium mixture formed by the Haber process.

substance	partial pressure / kPa
nitrogen	7000
hydrogen	8000
ammonia	4000



What is the numerical value of the equilibrium constant,  $K_p$ , for this reaction?

- A**  $4.46 \times 10^{-9}$   
**B**  $4.76 \times 10^{-5}$   
**C**  $7.14 \times 10^{-5}$   
**D**  $2.24 \times 10^8$

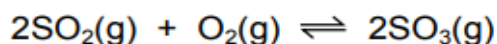
19) The responses **A** to **D** should be selected on the basis of

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>1, 2 and 3</b> are correct	<b>1 and 2</b> only are correct	<b>2 and 3</b> only are correct	<b>1 only</b> is correct

No other combination of statements is used as a correct response.



In the manufacture of sulfuric acid, the following exothermic reaction occurs.

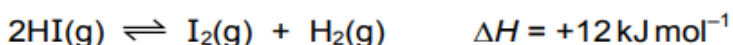


Which changes will move the position of the equilibrium to the right?

- 1 increasing the pressure
- 2 increasing the temperature
- 3 using twice as much catalyst

20)

Hydrogen iodide gas decomposes reversibly producing iodine vapour and hydrogen.



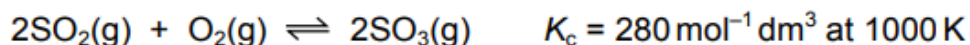
The position of the equilibrium for this reaction may be altered by changing the external conditions.

Which row correctly describes the change in position of equilibrium?

	effect of increasing the pressure	effect of increasing the temperature
<b>A</b>	moves to the right	moves to the right
<b>B</b>	moves to the right	moves to the left
<b>C</b>	no change	moves to the right
<b>D</b>	no change	moves to the left

21)

The reaction between sulfur dioxide and oxygen is reversible.



In an equilibrium mixture at 1000 K the sulfur trioxide concentration is  $6.00 \text{ mol dm}^{-3}$ .

The sulfur dioxide concentration is twice the oxygen concentration.

What is the sulfur dioxide concentration?

- A**  $0.175 \text{ mol dm}^{-3}$
- B**  $0.254 \text{ mol dm}^{-3}$
- C**  $0.318 \text{ mol dm}^{-3}$
- D**  $0.636 \text{ mol dm}^{-3}$



22) The responses **A** to **D** should be selected on the basis of

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

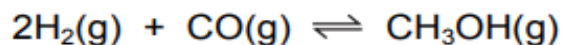
No other combination of statements is used as a correct response.

Which statements are correct when a reversible reaction is at equilibrium?

- 1 All species are at equal concentration.
- 2 The concentrations of all species remain constant.
- 3 The rate of the forward reaction equals the rate of the reverse reaction.

23)

Methanol can be produced from hydrogen and carbon monoxide.



What is the expression for  $K_p$  for this reaction?

**A**  $K_p = \frac{(2p_{\text{H}_2})^2 \times p_{\text{CO}}}{p_{\text{CH}_3\text{OH}}}$

**B**  $K_p = \frac{(p_{\text{H}_2})^2 \times p_{\text{CO}}}{p_{\text{CH}_3\text{OH}}}$

**C**  $K_p = \frac{p_{\text{CH}_3\text{OH}}}{(p_{\text{H}_2})^2 \times p_{\text{CO}}}$

**D**  $K_p = \frac{p_{\text{CH}_3\text{OH}}}{p_{\text{CO}} \times (2p_{\text{H}_2})^2}$

