Reaction rates and equilibrium (qualitative) – 2021/20 GCE AS Chemistry A

1. Nov/2021/Paper_H032/01/No.12

Which statement about dynamic equilibrium is **not** correct?

A A catalyst increases the rate of both forward and reverse reactions by the same amount.

B Dynamic equilibrium exists only in a closed system.

C The concentrations of the reactants and products are equal.

D The rate of the forward reaction is equal to the rate of the reverse reaction.

Your answer ☐ **[1]**

2. Nov/2021/Paper_H032/01/No.22(b)

(b) Explain how le Chatelier's principle can be used to predict the conditions of pressure and temperature for a maximum **equilibrium** yield of hydrogen in **Equilibrium 22.1**.

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..... **[4]**

3. Nov/2020/Paper_H032/01/No.12

Hydrogen gas can be produced as shown below.

$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$ $\Delta H = +206\,kJ\,mol^{-1}$

Which conditions produce the greatest equilibrium yield of hydrogen?

A Low temperature and high pressure

B Low temperature and low pressure

C High temperature and high pressure

D High temperature and low pressure

Your answer ☐ **[1]**

4. Nov/2020/Paper_H032/01/No.13

The reversible reaction below is in equilibrium.

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

The equilibrium concentrations are shown in the table.

Substance	$SO_2(g)$	$O_2(g)$	$SO_3(g)$
Equilibrium concentration / mol dm^{-3}	4.00	2.40	1.44

What is the numerical value of K_c?

A 0.0375

B 0.0540

C 0.150

D 18.5

Your answer ☐ **[1]**

5. Nov/2021/Paper_H032/02/No.5(a_ b)

Methanol, CH_3OH, is manufactured by the reaction of carbon monoxide, CO, with hydrogen, H_2.

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

(a) Write the expression for the equilibrium constant, K_c, for this equilibrium.

[1]

(b) A chemist mixes CO and H_2 in a container.
The mixture is heated to 200 °C and left to reach equilibrium.

The equilibrium concentrations of CO and H_2 are shown in the table.

Compound	Equilibrium concentration / mol dm^{-3}
CO(g)	0.57
H_2(g)	0.40

The numerical value of K_c for this equilibrium is 15.4.

(i) Calculate the equilibrium concentration of CH_3OH(g).

concentration = ... mol dm^{-3} **[2]**

(ii) What does the numerical value of K_c tell you about the position of equilibrium?

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..... **[1]**

(c) The industrial manufacture of methanol has used a copper-based catalyst.

Chemists have recently developed a new method for making methanol that uses a nickel-gallium catalyst. This allows methanol to be produced at a lower temperature than the old method.

Suggest **two** reasons why using a lower temperature is beneficial to the environment.

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2 .....

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[2]

6. Nov/2020/Paper_H032/02/No.4(b)

(b) Nitrosyl chloride, NOC*l*, dissociates into nitrogen monoxide and chlorine as in the equilibrium below.

$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$ $\Delta H = +77.0\,kJ\,mol^{-1}$

Nitrosyl chloride is added to a container, which is then sealed.
The container is heated to 400 °C, and equilibrium is allowed to be reached.

(i) Write the expression for the equilibrium constant, K_c, for this equilibrium.

[1]

(ii) In the equilibrium mixture at 400 °C, the equilibrium concentration of $Cl_2(g)$ is found to be $0.17\,mol\,dm^{-3}$.

The student calculates that the equilibrium concentration of NO(g) is $0.34\,mol\,dm^{-3}$.

Explain how the student obtained this value for [NO(g)].

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..... **[1]**

(iii) At 400 °C, $K_c = 0.015\,\text{mol dm}^{-3}$.

Calculate the equilibrium concentration of NOC*l*(g) at 400 °C.

equilibrium concentration of NOC*l*(g) = ... mol dm^{-3} **[2]**

(iv) The temperature of the equilibrium mixture is increased above 400 °C while keeping the pressure constant.

State and explain the effect on the equilibrium concentration of nitrogen monoxide, NO(g), with these new conditions.

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..... **[2]**