

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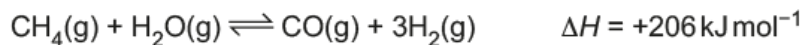
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..... **[4]**

## 3. Nov/2020/Paper\_H032/01/No.12

Hydrogen gas can be produced as shown below.



Which conditions produce the greatest equilibrium yield of hydrogen?

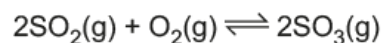
- A Low temperature and high pressure
- B Low temperature and low pressure
- C High temperature and high pressure
- D High temperature and low pressure

Your answer

[1]

## 4. Nov/2020/Paper\_H032/01/No.13

The reversible reaction below is in equilibrium.



The equilibrium concentrations are shown in the table.

Substance	$\text{SO}_2(\text{g})$	$\text{O}_2(\text{g})$	$\text{SO}_3(\text{g})$
Equilibrium concentration / $\text{mol dm}^{-3}$	4.00	2.40	1.44

What is the numerical value of  $K_c$ ?

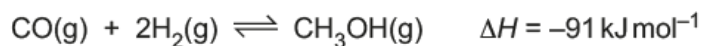
- A 0.0375
- B 0.0540
- C 0.150
- D 18.5

Your answer

[1]

## 5. Nov/2021/Paper\_H032/02/No.5(a\_b)

Methanol,  $\text{CH}_3\text{OH}$ , is manufactured by the reaction of carbon monoxide,  $\text{CO}$ , with hydrogen,  $\text{H}_2$ .



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

[1]

(b) A chemist mixes  $\text{CO}$  and  $\text{H}_2$  in a container.  
The mixture is heated to  $200^\circ\text{C}$  and left to reach equilibrium.

The equilibrium concentrations of  $\text{CO}$  and  $\text{H}_2$  are shown in the table.

Compound	Equilibrium concentration / $\text{mol dm}^{-3}$
$\text{CO(g)}$	0.57
$\text{H}_2\text{(g)}$	0.40

The numerical value of  $K_c$  for this equilibrium is 15.4.

(i) Calculate the equilibrium concentration of  $\text{CH}_3\text{OH(g)}$ .

concentration = .....  $\text{mol dm}^{-3}$  [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.

1 .....

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2 .....

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[2]

6. Nov/2020/Paper\_H032/02/No.4(b)

- (b) Nitrosyl chloride,  $\text{NOCl}$ , dissociates into nitrogen monoxide and chlorine as in the equilibrium below.



Nitrosyl chloride is added to a container, which is then sealed.

The container is heated to  $400^\circ\text{C}$ , 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  $400^\circ\text{C}$ , the equilibrium concentration of  $\text{Cl}_2\text{(g)}$  is found to be  $0.17 \text{ mol dm}^{-3}$ .

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

Explain how the student obtained this value for  $[\text{NO(g)}]$ .

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..... [1]

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

Calculate the equilibrium concentration of  $\text{NOCl(g)}$  at  $400^{\circ}\text{C}$ .

equilibrium concentration of  $\text{NOCl(g)} = \dots\dots\dots \text{ mol dm}^{-3}$  [2]

- (iv) The temperature of the equilibrium mixture is increased above  $400^{\circ}\text{C}$  while keeping the pressure constant.

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

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..... [2]