education

MPUMALANGA PROVINCE

REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES TOPIC TEST

TOPIC: CHEMICAL EQUILIBRIUM

21 MAY 2024 (PROPOSED DATE)

MARKS: 25

TIME: 30 minutes

This question paper consists of 5 pages and 1 data sheet

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of THREE questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH Question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave one line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEET.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, etc, where required.
12. Write neatly and legibly.

QUESTION 1

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1 to 1.2) in the ANSWER BOOK, eg. 1.3 E

1.1 Initially, a certain amount of SO_2 and O_2 are sealed in an empty flask at a certain temperature. The reaction that takes place is:

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

Which of the following statements describe(s) the change(s) occurring as the system proceeds towards equilibrium?

i. The rate of the reverse reaction increases.
ii. The concentration of $SO_2(g)$ increases.
iii. The concentration of SO_3 (g) increases.

A i only

B ii only

C i and iii only

D ii and iii only (2)

1.2 A hypothetical reaction reaches equilibrium at 10 °C in a closed container according to the following balanced equation:

$$A(g) + B(g) \rightleftharpoons AB(g)$$

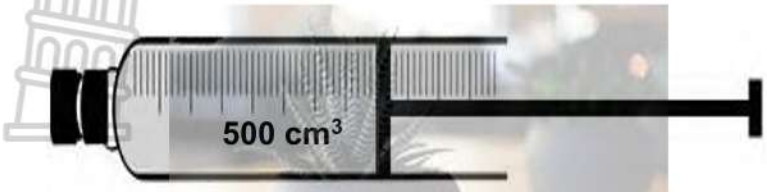
The catalyst is now added to the reaction mixture.
Which ONE of the following is correct as the reaction approaches a new equilibrium?

	RATE OF FORWARD REACTION	RATE OF REVERSE REACTION	YIELD OF PRODUCTS
A	Increases	Decreases	Increases
B	Increases	Increases	Remains constant
C	Increases	Decreases	Remains constant
D	Increases	Increases	Increases

(2)
[4]

QUESTION 2

The reversible reaction represented by the balanced equation below, reaches equilibrium in a 500 cm^3 closed syringe at 380 K.



$$4HCl(g) + O_2(g) \rightleftharpoons 2Cl_2(g) + 2H_2O(l)$$

The equilibrium constant (Kc) for this reaction is 4×10^2 at 380 K.

2.1 Define the term chemical equilibrium. (2)

2.2 Is the yield of $Cl_2(g)$ at 380 K HIGH or LOW? Give a reason for the answer. (2)

2.3 Calculate the amount of $Cl_2(g)$ in mol, at equilibrium (380 K) if all the other substances are present in equal amounts of 0,25 mol at equilibrium. (6)

2.4 When the temperature is increased to 550 K, the amount of HCl(g) in the syringe increases. What is the sign of ΔH for the forward reaction? Write down POSITIVE or NEGATIVE. Use Lech ateliers principle to explain the answer. (3)

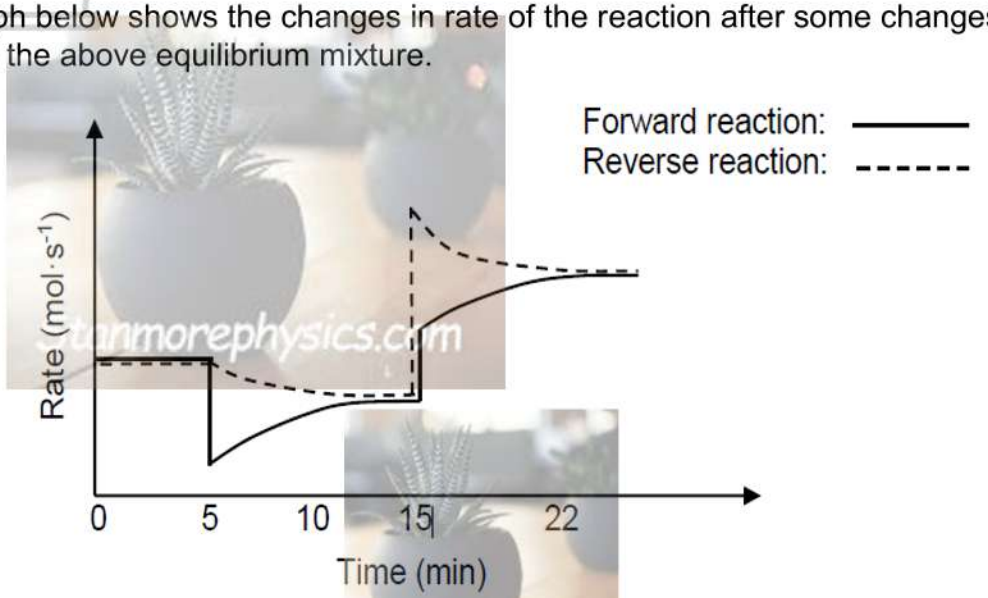
[13]

QUESTION 3

The reaction represented by the equation below reaches equilibrium in a closed container at a certain temperature.

$$2O_3(g) \rightleftharpoons 3O_2(g) \qquad \Delta H > 0$$

The graph below shows the changes in rate of the reaction after some changes are made to the above equilibrium mixture.



3.1 State Lech atelier's principle. (2)

3.2 Write down the disturbance responsible for the sudden change in reaction rate at the 5th minute. (1)

3.3 A change is made either in temperature or pressure at 15th minute. Write down this change. (1)

3.4 Explain the answer in QUESTION 3.3. (3)

3.5 The volume of the container is now increased. Which reaction will be favoured by this change? Write down only FORWARD REACTION or REVERSE REACTION. (1)

[8]

TOTAL: 25

DATA FOR PHYSICAL SCIENCES GRADE 12

PAPER 2 (CHEMISTRY)

TABLE 1: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$

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Marking guidelines

MARKS: 25

These marking guidelines consist of 4 pages

QUESTION 1

1.1 C✓✓ (2)

1.2 B✓✓ (2)
[4]

QUESTION 2

2.1 A dynamic equilibrium when the rate of the forward reaction equals the rate of the reverse reaction.✓✓ **[2 or 0 mark]** (2)

2.2 HIGH✓
Large Kc value / Kc value is greater than 1.✓ (2)

2.3

Marking criteria	
• Divide $(n)_{equilibrium}$ of HCl and O_2 by 0,5 dm^3	✓
• Kc expression	✓
• Substitute Kc values into Kc expression	✓
• Substitute $(c)_{equilibrium}$ into Kc expression	✓
• Multiply [HCl] with 0,5dm^3	✓
• Final answer.	✓

OPTION 1

	HCl	O_2	Cl_2
Equilibrium mole	0,25	0,25	
[Equilibrium]	$\frac{0,25}{0,5}$ = 0,5	$\frac{0,25}{0,5}$ = 0,5	$\frac{X}{0,5}$ ✓÷ by 0,5

$K_c = \frac{[Cl_2]^2}{[HCl][O_2]}$✓

$4\ x\ 10^2$✓ = $\frac{(\frac{x}{0,5})2}{(0,5)(0,5)}$✓✓

X = 5 mol✓

OPTION 2

	HCl	O_2	Cl_2
Equilibrium mole	0,25	0,25	
[Equilibrium]	$\frac{0,25}{0,5}$ = 0,5	$\frac{0,25}{0,5}$ = 0,5	X ✓÷ by 0,5

$$K_c = \frac{[Cl_2]^2}{[HCl][O_2]}$$ ✓

$$4\ x\ 10^2 \checkmark = \frac{X^2}{(0,5)(0,5)} \checkmark$$

X = $[Cl_2]$ = 10 mol.dm^{-3}
n = cv
n = 10 x 0,5✓
n = 5 mol✓

OPTION 3

C(HCl) = C(O_2) = $\frac{n}{v}$

C = $\frac{0,25}{0,5}$ ✓

C = 0,5 mol.dm^{-3}

$$K_c = \frac{[Cl_2]^2}{[HCl][O_2]}$$ ✓

$$4\ x\ 10^2 \checkmark = \frac{X^2}{(0,5)(0,5)} \checkmark$$

X = $[Cl_2]$ = 10 mol.dm^{-3}
n = cv
n = 10 x 0,5✓
n = 5 mol✓

(6)

2.4 NEGATIVE✓
- Increase in temperature favours the reverse endothermic reaction.✓
- Therefore forward reaction is exothermic✓

(3)
[13]

QUESTION 3

3.1 When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose/cancel the disturbance.✓✓ **[2 or 0 mark]** (2)

3.2 Reactatnt is removed✓
OR: O_3 is removed (1)

3.3 Pressure increased✓ (1)

3.4
- Rate of both forward and reverse reactions increases, but the reverse reaction increases more.✓
- increase in pressure favours a reaction that produces a lower number of moles of a gas.✓
- Reverse reaction is favoured/faster than the forward reaction (because it occurs with a decrease in number of moles).✓ (3)

3.5 FORWARD REACTION (1)

[8]

TOTAL: 25