



education

MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

**FURTHER EDUCATION
AND TRAINING**

GRADE 12

PHYSICAL SCIENCES TOPIC TEST

TOPIC: CHEMICAL EQUILIBRIUM

16 MAY 2025 (Proposed date)

MARKS: 27

TIME: 33 minutes

This question paper consists of 5 pages and 2 data sheets

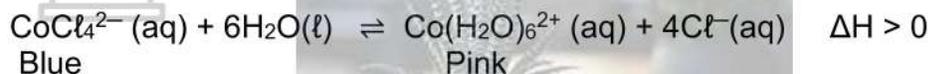
INSTRUCTIONS AND INFORMATION

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: MULTIPLE-CHOICE QUESTIONS

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.1.3E

1.1 The reaction represented by the equation below reaches equilibrium.



A few drops of Cl^- ions are added to the reaction mixture and the reaction vessel is cooled.

Which ONE of the following combinations CORRECTLY describes the effect on equilibrium constant, K_c and the colour change of the solution.

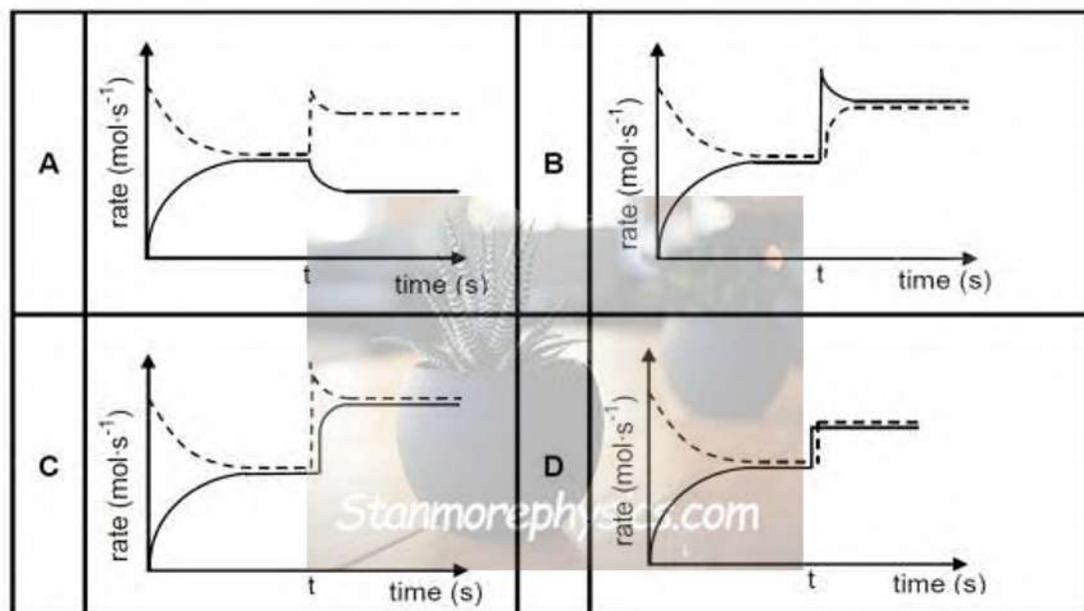
	K_c VALUE	COLOUR CHANGE
A	No effect	Solution turns pink
B	No effect	Solution turns blue
C	Increases	Solution turns pink
D	Decreases	Solution turns blue

(2)

1.2 Initially, a certain amount of $\text{X}(\text{g})$ was placed in an empty container. The hypothetical reaction reaches equilibrium in a closed container according to the following balanced equation: $\text{X}(\text{g}) \rightleftharpoons 2\text{Y}(\text{g}) \quad \Delta H < 0$

At time t , the temperature is increased.

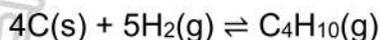
Which graph below best illustrates the resulting changes in the rates of the forward and reverse reactions after the temperature is increased?



(2)
[4]

QUESTION 2

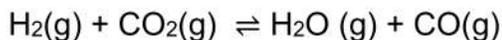
The reaction represented below reaches equilibrium in a closed container.



The equilibrium constants for this reaction at two different temperatures are given in the table below.

TEMPERATURE (K)	EQUILIBRIUM CONSTANT (K _c)
400	1,58 x 10 ⁻³
600	1,58 x 10 ⁻⁹

- 2.1 State Le Chatelier's principle. (2)
- 2.2 Is the forward reaction ENDOTHERMIC or EXOTHERMIC? (1)
- 2.3 Use Le Chatelier's principle to explain the answer in QUESTION 2.2. (3)
- 2.4 The pressure in the container is now decreased by increasing the volume of the container. What effect will this have on the concentration of C₄H₁₀(g)? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)
- 2.5 A reversible reaction is represented by the balanced equation below.



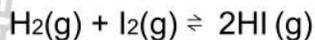
Initially **Q** moles of H₂(g) is mixed with 0,3 moles of CO₂(g) in a 10dm³ reaction vessel. At equilibrium, there is 0,02 mol.dm⁻³ of CO(g) and the equilibrium constant(K_c) at that specific temperature is 4.

Calculate the initial number of moles, **Q** of H₂(g) initially in the reaction vessel.

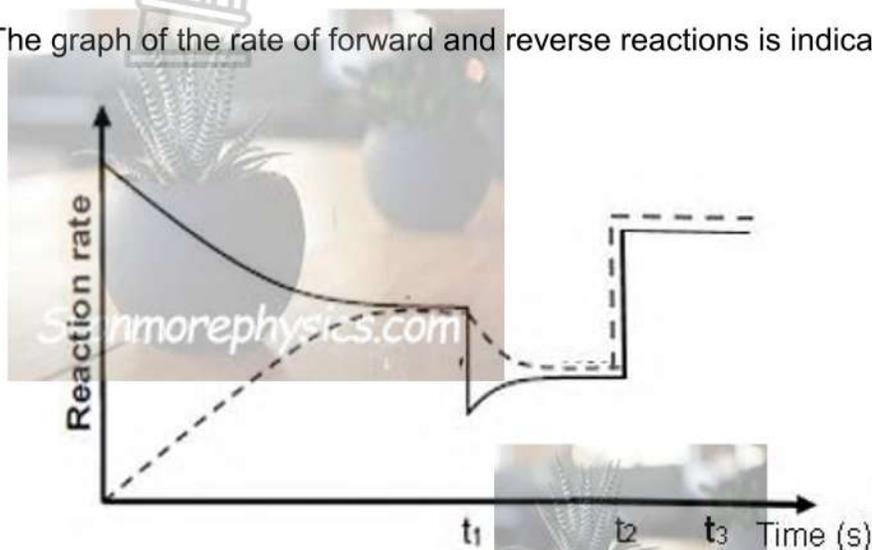
(7)
[16]

QUESTION 3

Hydrogen iodide, HI gas is produced by reacting hydrogen gas and hydrogen gas in a closed container according to the following balanced equation:



The graph of the rate of forward and reverse reactions is indicated below.



- 3.1 Define the term *chemical equilibrium*. (2)
 - 3.2 What change is made to the equilibrium mixture at time t_1 ?. (1)
 - 3.3 Explain the answer in question 3.2. (2)
 - 3.4 State ONE possible change that is made to the reaction conditions at time t_2 (1)
 - 3.5 What do the parallel lines at time t_3 indicate? (1)
- [7]**

TOTAL:27

DATA FOR PHYSICAL SCIENCES GRADE 12

PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	p^θ	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature	T^θ	273 K
Charge on electron	e	$-1,6 \times 10^{-19} \text{ C}$
Avogadro's' number	N_A	$6,02 \times 10^{23}$

TABLE 2: FORMULAE

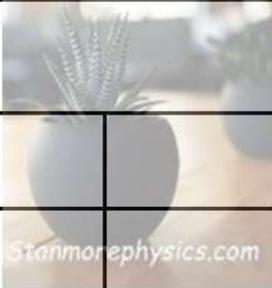
$n = \frac{m}{M}$		$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or $c = \frac{m}{MV}$	Stanmorephysics.com	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

I		II		Relative atomic mass (approximately)										III							IV	V	VI	VII	0																																
KEY		Atomic number		Electronegativity		Symbol		Relative atomic mass (approximately)		Symbol		Relative atomic mass (approximately)		Symbol		Relative atomic mass (approximately)		Symbol		Relative atomic mass (approximately)		Symbol		Relative atomic mass (approximately)		Symbol		Relative atomic mass (approximately)																													
1	H	4	Be	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																						
2	He	9	F	10	Ne	11	B	12	C	13	Al	14	Si	15	P	16	S	17	Cl	18	Ar	19	K	20	Ca	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr
3	Li	11	Na	19	K	37	Rb	55	Cs	87	Fr	88	Ra	89	Ac	90	Th	91	Pa	92	U	93	Np	94	Pu	95	Am	96	Cm	97	Bk	98	Cf	99	Es	100	Fm	101	Md	102	No	103	Lr														
4	Be	12	Mg	20	Ca	38	Sr	56	Ba	88	Ra	89	Ac	90	Th	91	Pa	92	U	93	Np	94	Pu	95	Am	96	Cm	97	Bk	98	Cf	99	Es	100	Fm	101	Md	102	No	103	Lr																
5	B	13	Al	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																						
6	C	14	Si	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																								
7	N	15	P	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																										
8	O	16	S	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																												
9	F	17	Cl	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																														
10	Ne	18	Ar	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																																
11	Na	19	K	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																																		
12	Mg	20	Ca	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																																				
13	Al	21	Sc	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																																						
14	Si	22	Ti	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																																								
15	P	23	V	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr																																										
16	S	24	Cr	32	Ge	33	As	34	Se	35	Br	36	Kr																																												
17	Cl	25	Mn	33	As	34	Se	35	Br	36	Kr																																														
18	Ar	26	Fe	34	Se	35	Br	36	Kr																																																
19	K	27	Co	35	Br	36	Kr																																																		
20	Ca	28	Ni	36	Kr																																																				
21	Sc	29	Cu	37	Rb	55	Cs	87	Fr																																																
22	Ti	30	Zn	38	Sr	88	Ra																																																		
23	V	31	Ga	39	Y	89	Ac																																																		
24	Cr	32	Ge	40	Zr	90	Th																																																		
25	Mn	33	As	41	Nb	91	Pa																																																		
26	Fe	34	Se	42	Mo	92	U																																																		
27	Co	35	Br	43	Tc	93	Np																																																		
28	Ni	36	Kr	44	Ru	94	Pu																																																		
29	Cu	37	Rb	45	Rh	95	Am																																																		
30	Zn	38	Sr	46	Pd	96	Cm																																																		
31	Ga	39	Y	47	Ag	97	Bk																																																		
32	Ge	40	Zr	48	Cd	98	Cf																																																		
33	As	41	Nb	49	In	99	Es																																																		
34	Se	42	Mo	50	Sn	100	Fm																																																		
35	Br	43	Tc	51	Sb	101	Md																																																		
36	Kr	44	Ru	52	Te	102	No																																																		
37	Rb	45	Rh	53	I	103	Lr																																																		
38	Sr	46	Pd	54	Xe	104																																																			
39	Y	47	Ag	55		105																																																			
40	Zr	48	Cd	56		106																																																			
41	Nb	49	In	57		107																																																			
42	Mo	50	Sn	58		108																																																			
43	Tc	51	Sb	59		109																																																			
44	Ru	52	Te	60		110																																																			
45	Rh	53	I	61		111																																																			
46	Pd	54	Xe	62		112																																																			
47	Ag	55		63		113																																																			
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49	In	57		65		115																																																			
50	Sn	58		66		116																																																			
51	Sb	59		67		117																																																			
52	Te	60		68		118																																																			
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Marking guidelines

MARKS: 27

These marking guidelines consist of 3 pages

QUESTION 1

1.1 D ✓✓ (2)

1.2 B ✓✓ (2)
[4]

QUESTION 2

2.1 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)

2.2 EXOTHERMIC ✓ (1)

2.3

- K_c decreases with increase in temperature ✓
- concentration of products decrease/ Reverse reaction is favoured ✓
- Increase in temperature favours endothermic reaction ✓

(3)

2.4

- DECREASES ✓
- The system re-instate a new equilibrium by favouring a reaction that increases pressure ✓
- The reverse reaction is favoured as it produces more number of moles ✓

(3)

2.5 **OPTION 1: USING (THE TABLE OF) NUMBER OF MOLES**

Reaction	H ₂	CO ₂ ⇌	H ₂ O	CO
Initial mole	Q	0,3	0	0
Change in mole	-0,2	-0,2	0,2	0,2 ✓
Equilibrium mole	Q-0,2	0,1	0,2	0,2 ✓
Equilibrium concentration (Mol.dm ⁻³)	$\frac{Q-0,2}{10}$	0,01	0,02	0,02 ✓

$$K_c = \frac{[CO][H_2O]}{[H_2][CO_2]} \quad \checkmark$$

$$4 \checkmark = \frac{(0,02)(0,02)}{\left(\frac{Q-0,2}{10}\right)(0,01)} \quad \checkmark$$

Q = 0,3 n(H₂) = 0,3 mol ✓

OPTION 2: USING (THE TABLE OF) CONCENTRATION

Reaction	H ₂	CO ₂ ⇌	H ₂ O	CO
C(Initial)	$\frac{Q}{10}$	0,03 ✓	0	0
ΔC	0,02	0,02	0,02	0,02 ✓
Equilibrium concentration (Mol.dm ⁻³)	$(\frac{Q}{10}) - 0,02$	0,01	0,02	0,02 ✓

$$K_c = \frac{[CO][H_2O]}{[H_2][CO_2]}$$

$$4 \checkmark = \frac{(0,02)(0,02)}{(\frac{Q}{10} - 0,02)(0,01)} \checkmark$$

$$Q = 0,3 \quad n(H_2) = 0,3 \text{ mol} \checkmark$$

No K _c expression but correct substitution:	Max: 6mks
Wrong K _c expression:	Max: 3 mks

(7)
[16]

QUESTION 3

- 3.1 A dynamic equilibrium when the rate of the forward reaction equals the rate of the reverse reaction. ✓✓ (2)
- 3.2 H₂/I₂/ Reactants removed ✓ (1)
- 3.3
- The rate of the reverse reaction decreases less ✓
 - Reverse reaction is favoured because it causes increase of reactants ✓ (2)
- 3.4 Increase in pressure/addition of a catalyst ✓ (1)
- 3.5 Chemical/dynamic equilibrium. ✓ (1)

TOTAL:27