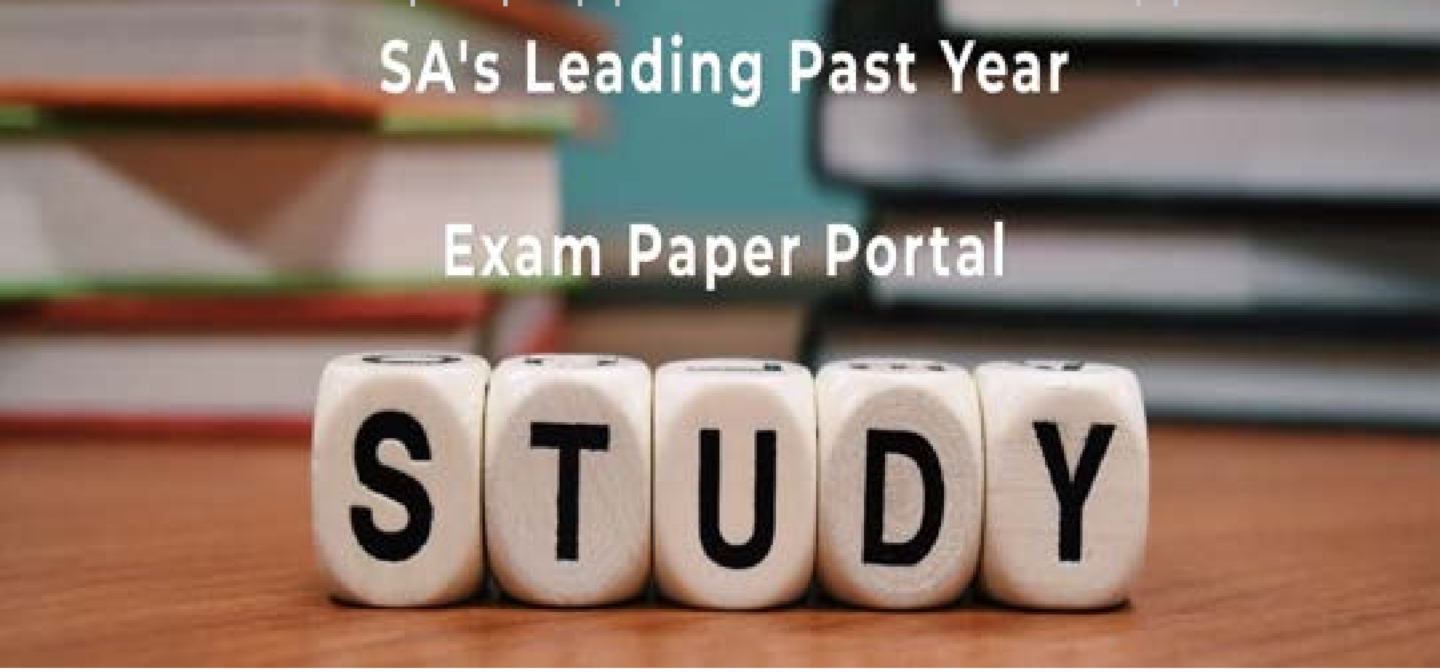
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GRADE 12

PHYSICAL SCIENCES: CHEMISTRY P2

JUNE 2025

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of SEVEN 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 SHEETS.
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, et cetera where required.
12. Write neatly and legibly.

QUESTION 1 : MULTIPLE-CHOICE QUESTIONS

Four 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 – 1.10) in the ANSWER BOOK, for example, 1.11 E.

1.1 Which ONE of the following compounds is an alkyne?

A C_6H_{12}

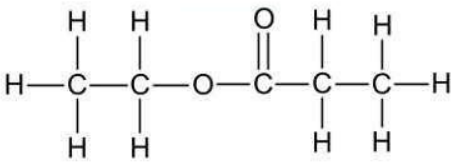
B C_4H_6

C $C_{10}H_{22}$

D C_4H_8O (2)

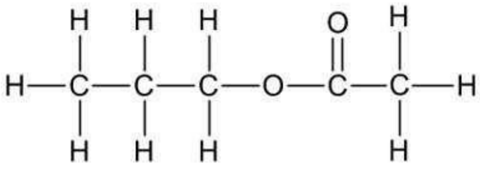
1.2 Which ONE of the following is a functional isomer of ethyl propanoate?

A



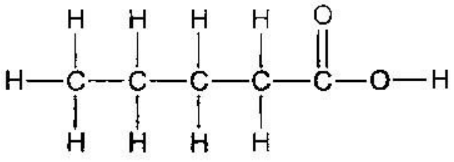
$$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-O-\overset{O}{\overset{\|}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H$$

B



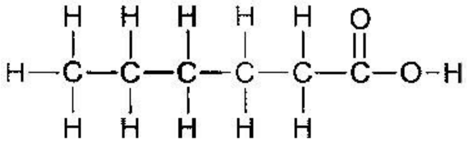
$$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-O-\overset{O}{\overset{\|}{C}}-\underset{H}{\overset{H}{C}}-H$$

C



$$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\overset{O}{\overset{\|}{C}}-O-H$$

D



$$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\overset{O}{\overset{\|}{C}}-O-H$$

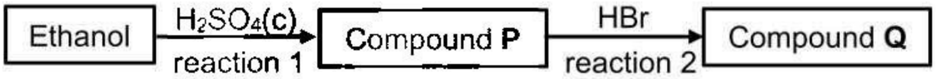
(2)

1.3 For which ONE of the following pairs of compounds will **X** have a higher boiling point than **Y**?

	X	**Y**
A	$CH_3CH(CH_3)CH_3$	$CH_3CH_2CH_2CH_3$
B	CH_3CH_3	$CH_3CH_2CH_3$
C	$CH_3CH_2CH_2CH_3$	$CH_3CH_2COCH_3$
D	CH_3COOH	$CH_3CH_2CH_2OH$

(2)

1.4 Ethanol can be converted into other carbon-containing compounds using the reactants as shown in the flow chart below.



Compounds P and Q are, respectively:

	P	**Q**
A	Ethene	Bromoethane
B	Ethanoic acid	Ethanol
C	Ethene	Bromoethene
D	Ethanol	Ethanoic acid

(2)

1.5 A piece of magnesium ribbon reacts with excess hydrochloric acid according to the following equation:

$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

Which ONE of the following changes will NOT affect the reaction rate?

A Putting the reaction mixture in a hot water bath

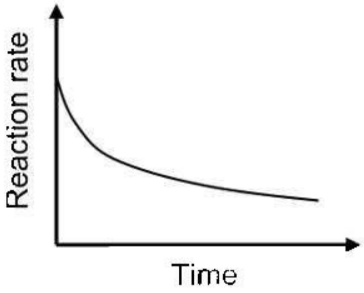
B Using the same mass of powdered magnesium

C Increasing the volume of the hydrochloric acid

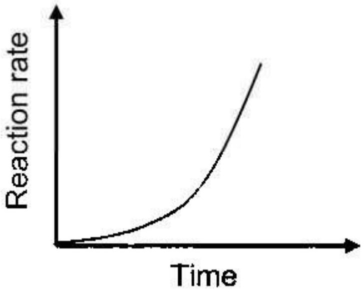
D Increasing the concentration of the hydrochloric acid. (2)

1.6 Which ONE of the reaction rate versus time graphs below best represents the reaction between magnesium and EXCESS dilute hydrochloric acid?

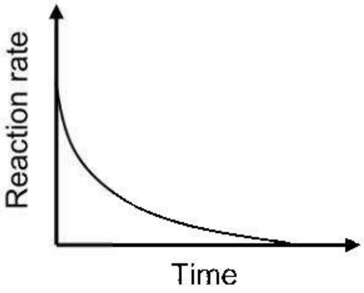
A



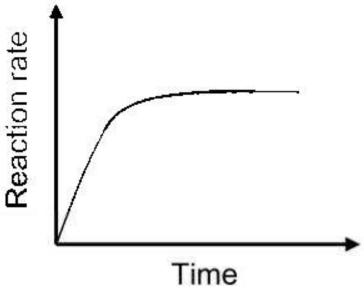
B



C



D



(2)

1.7 Which ONE of the following will NOT affect the equilibrium position of reversible chemical reactions?

A Temperature

B Catalyst

C Pressure

D Concentration (2)

1.8 The reaction given below reaches equilibrium in a closed container. The K_c value is 0,04 at a certain temperature.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H < 0$$

Which ONE of the following factors will change the K_c value to 0,4?

A Increase in pressure

B Decrease in pressure

C Increase in temperature

D Decrease in temperature (2)

1.9 During a titration to determine the concentration of an acid using a standard solution of a base, a learner pipettes the base into a conical flask. The learner then uses a small amount of water to rinse the inside of the flask so that all the base is part of the solution in the flask.

How will the extra water added to the flask affect the results of this titration?

The concentration of the acid …

A cannot be determined.

B will be lower than expected.

C will be higher than expected.

D will be the same as expected. (2)

1.10 Which ONE of the following statements is ALWAYS true for monoprotic acids?

A The lower the concentration of the acid solution, the weaker the acid.

B There will be more H_3O^+ ions in 100 cm^3 of a strong acid solution than in 100 cm^3 of a weak acid solution.

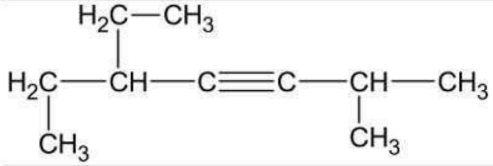
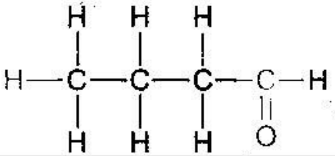
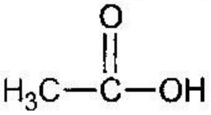
C The pH of a strong acid is lower than the pH of a weak acid.

D One mole of a strong acid will produce more H_3O^+ ions in water than one mole of a weak acid. (2)

[20]

QUESTION 2 (Start on a new page)

The letters **A** tot **H** in the table below represent EIGHT organic compounds.

A	2,4-dichloro-3-ethyl-6-methyloctane	**B**	 $H_2C(CH_3)-CH(CH_2CH_3)-C\equiv C-CH(CH_3)-CH_3$
C		**D**	$CH_3CH_2CHOHCH_3$
E	 $H_3C-C(=O)-OH$	**F**	C_5H_{12}
G	$CH_3COCH_2CH_3$	**H**	Butan-1-ol

2.1 Write down the LETTER(S) that represents the following

2.1.1 A functional isomer of compound **G**. (1)

2.1.2 A haloalkane (1)

2.1.3 Belongs to the same homologous series as compound **H**. (1)

2.2 Write down the:

2.2.1 IUPAC name of compound **B**. (3)

2.2.2 Structural formula of compound **A**. (3)

2.2.3 Name of the homologous series to which compound **C** belongs. (1)

2.2.4 Structural formula of the FUNCTIONAL GROUP of compound **G**. (1)

2.3 Consider compound **D**

2.3.1 Define the term *positional isomer.* (2)

2.3.2 Write down the STRUCTURAL FORMULA of the positional isomer of compound **D**. (2)

2.3.3 Is compound **D** a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer. (2)

2.4 Compound **E** and **H** are heated together in the presence of a catalyst in a test tube to produce an ESTER.

Write down the:

2.4.1 Name of the reaction that takes place. (1)

2.4.2 NAME or FORMULA of the catalyst used. (1)

2.4.3 STRUCTURAL FORMULA of the ester that is produced. (2)

2.4.4 IUPAC name of the ester that is produced. (2)

2.5 The reaction below illustrates the complete combustion of compound **F** in EXCESS oxygen.

$$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$$

45 g of compound **F** reacts completely with oxygen at standard temperature and pressure (STP). If the percentage yield of carbon dioxide (CO_2) is 76%, calculate the volume of carbon dioxide formed. (5)

[28]

QUESTION 3 (Start on a new page.)

Students use alcohols **A** to **C** to investigate a factor that affects the boiling point of alcohols.

They use equal volumes of each alcohol and heat them separately in a water bath.

Compounds	**Alcohols**
A	CH_3OH
B	CH_3CH_2OH
C	$CH_3CH_2CH_2OH$

3.1 Define the term *boiling point*. (2)

3.2 What property of alcohols makes it necessary for them to be heated in a water bath? (1)

3.3 What structural requirements must the alcohols meet to make this a fair comparison? (2)

3.4 Write down the:

3.4.1 Independent variable. (1)

3.4.2 Name of the FUNCTIONAL GROUP of these compounds. (1)

3.4.3 IUPAC name of compound **B** (1)

3.5 Which ONE of the three compounds has the HIGHEST boiling point? (1)

3.6 Explain the answer to QUESTION 3.5 in full. (3)

3.7 The boiling point of compound **C** is now compared with that of compound **X**.

COMPOUND		**BOILING POINT (°C)**
C	$CH_3CH_2CH_2OH$	98
X	CH_3COOH	118

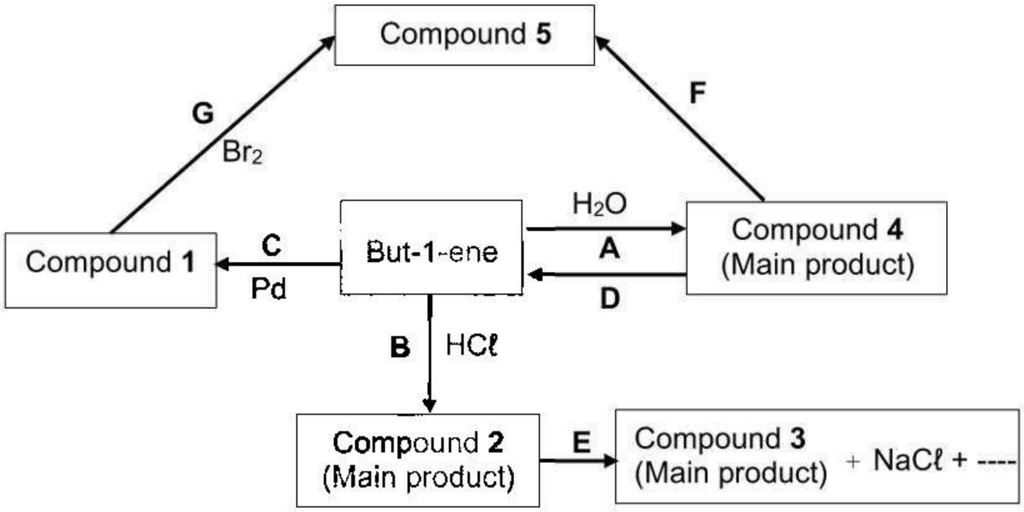
3.7.1 Besides the conditions used to determine boiling points, give a reason why this is a fair comparison. (1)

3.7.2 Fully explain the difference in the boiling points of compounds **C** and **X**. (4)

[17]

QUESTION 4 (Start on a new page.)

The flow chart below shows how alkenes can be used to prepare other organic compounds. The letters **A** to **G** represent different organic reactions.



4.1 Write down the type of reaction represented by:

4.1.1 C (1)

4.1.2 F (1)

4.1.3 D (1)

4.2 For reaction **A** write down the:

4.2.1 IUPAC name of compound **4**. (2)

4.2.2 NAME or FORMULA of the inorganic reactant needed for this reaction. (1)

4.2.3 Type of addition reaction. (1)

4.3 For reaction **G**, bromine water is added to compound **1**.

4.3.1 Is compound **1** a saturated or unsaturated? Give a reason for the answer. (2)

4.3.2 Write down the reaction condition for this reaction. (1)

4.4 Write down a balanced chemical equation using STRUCTURAL FORMULAE for reaction **E**. (6)

4.5 For reaction **B** write down two reaction conditions required for this reaction (2)

[18]

QUESTION 5 (Start on a new page.)

A student is asked to design an industrial process to produce sulphuric acid.

5.1 One of the reactions in the production of sulphuric acid is the roasting (heating in oxygen) of a metal ore that contains lead(II) sulphide:

$$2PbS(s) + 3O_2(g) \rightarrow 2PbO(s) + 2SO_2(g)$$

The student does a test experiment in which 36,8 g of O_2 gas completely reacts with 800 g of the metal ore. All of the PbS in the ore reacts, and ONLY the PbS in the ore reacts with the oxygen.

5.1.1 Calculate the amount (in moles) of O_2 that reacted. (3)

5.1.2 Calculate the mass of pure PbS in the metal ore. (3)

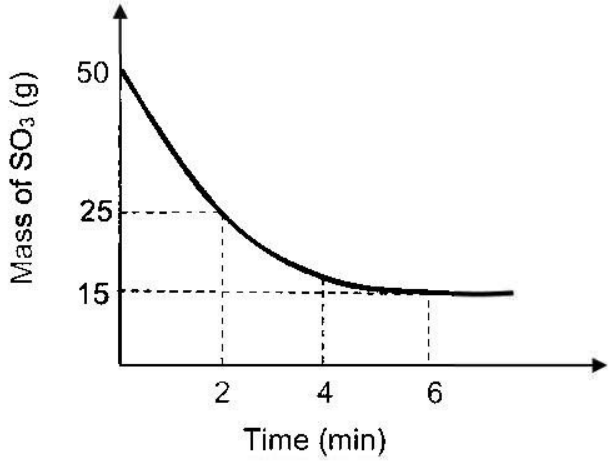
5.1.3 Calculate the percentage mass of the PbS in the metal ore. (2)

5.2 In another experiment, 50 g of sulphur trioxide reacts with water:

$$SO_3(g) + H_2O(\ell) \rightarrow H_2SO_4(\ell)$$

The amount of sulphur trioxide present in the container is monitored over time.

The following graph is plotted:



5.2.1 Write down the formula of the limiting reactant. (1)

5.2.2 At what time on the graph was the reaction rate the fastest. (1)

5.2.3 What happened at 6 minutes. (1)

5.2.4 Define the term *reaction rate*. (2)

5.2.5 Calculate the rate of the reaction in ($g \cdot s^{-1}$) during the first 2 minutes. (3)

5.2.6 Copy the above graph in your answer book. On the same set of axes, use a DOTTED LINE to show the curve that will be obtained when the temperature increases. No numerical values are required. (2)

5.2.7 In terms of the COLLISION THEORY, explain why the rate of a chemical reaction increases with increasing temperature. (3)

[23]

QUESTION 6 (Start on a new page)

6.1 Nitrosyl chloride ($NOC\ell$) is a yellow gas that decomposes into colourless nitrogen monoxide gas (NO) and green chlorine gas ($C\ell_2$) at temperatures above 100 °C.

$$\underset{\text{Yellow}}{2NOC\ell(g)} \rightleftharpoons 2NO(g) + \underset{\text{Green}}{C\ell_2(g)}$$

Consider an equilibrium mixture of $NOC\ell$, NO, and $C\ell_2$, which is initially yellow–green, in a sealed container.

6.1.1 Explain the term *closed system*. (1)

6.1.2 NO(g) is added to the container at constant volume. What colour change will be observed in the container. Explain the answer (4)

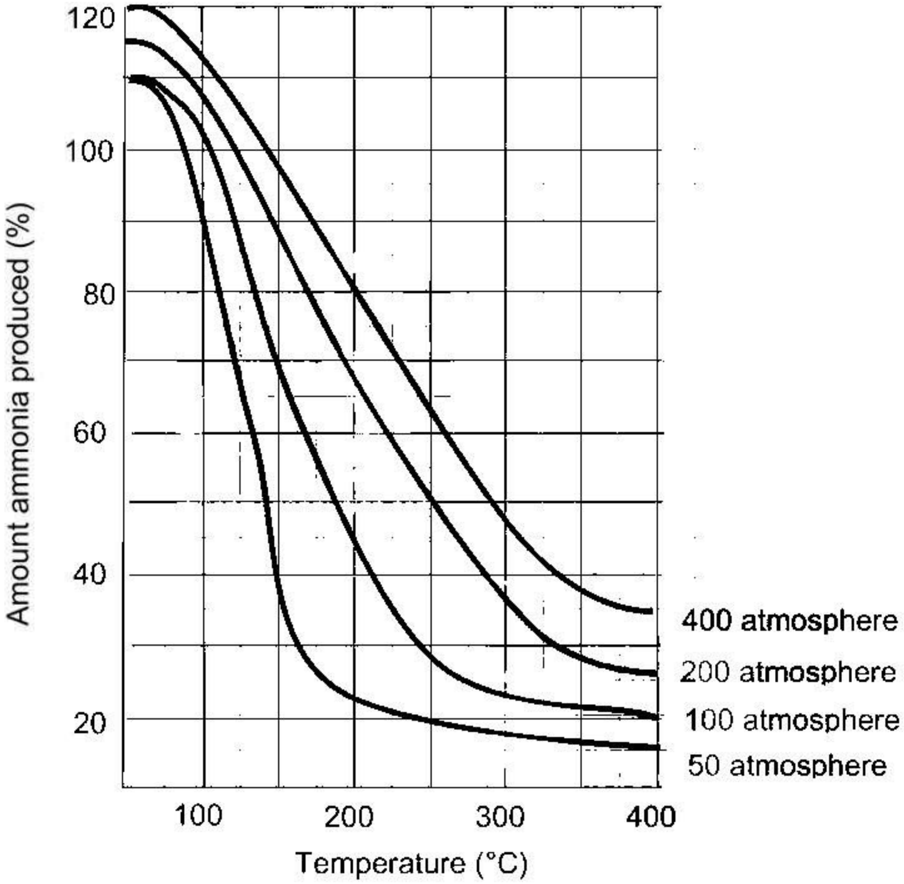
6.1.3 State *Le Chatelier's principle*. (2)

6.1.4 When the pressure in the container is changed, the colour becomes green. Use Le Chatelier's principle to explain whether the pressure was INCREASED or DECREASED. (4)

6.2 The Haber process uses nitrogen and hydrogen gases to produce ammonia gas, represented in the reversible reaction below.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The Haber process was researched. The graph (below) shows how the percentage yield of ammonia is affected by changes in temperature and pressure.



In industry, the Haber process is typically operated at a temperature of 250 °C and a pressure of 200 atmospheres (200 atm).

6.2.1 Is the forward reaction in the Haber process EXOTHERMIC or ENDOTHERMIC? (1)

6.2.2 Explain the answer to Question 6.2.1 in terms of Le Chatelier's principle by referring to the graph. (4)

6.2.3 What is the percentage yield of ammonia at 250 °C and 200 atmosphere? (1)

6.3 A solution is prepared by dissolving 4 mol of $CuC\ell_4^{2-}$ completely in water to make a solution of volume 2 dm^3. When equilibrium is established, there are 2,2 mol of $Cu(H_2O)_6^{2+}$ ions present at 25 °C.

$$Cu(H_2O)_6^{2+}(aq) + 4C\ell^-(aq) \rightleftharpoons CuC\ell_4^{2-}(aq) + 6H_2O(\ell)$$

Determine the value of the equilibrium constant, K_c, for this reaction at 25 °C. (8)

[25]

QUESTION 7 (Start on a new page.)

Consider the following balanced chemical equations showing some acid-base reactions.

A $HNO_3 + KOH \rightarrow KNO_3 + H_2O$

B $H_2SO_3 + H_2O \rightleftharpoons HSO_3^- + H_3O^+$

7.1 Define an acid according to the Lowry- Brønsted theory. (2)

7.2 Consider the chemical equations (**A** and **B**) above.

7.2.1 Describe the term *amphoteric substance*. (2)

7.2.2 Write down the formula of an amphoteric chemical substance (other than H_2O). (1)

7.2.3 Write down the formulae of the conjugate acid-base pairs in reaction **B**. (2)

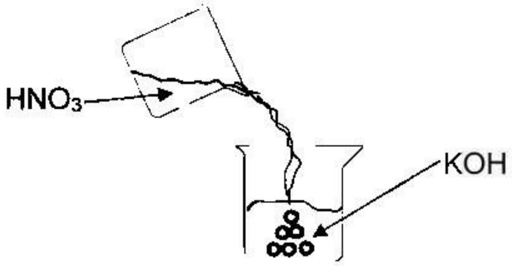
7.3 Which indicator must be used in reaction **A**. Choose from METHYL ORANGE, BROMOTHYMOL BLUE or PHENOLPHTHALEIN. Give a reason for the answer (3)

7.4 Consider reactions **A** and **C**, shown below.

A: $HNO_3 + KOH \rightarrow KNO_3 + H_2O$

C: $2HNO_3 + Na_2CO_3 \rightarrow 2NaNO_3 + CO_2 + H_2O$

A 13 g, impure sample of KOH is initially dissolved in 200 cm^3 of a 1,2 mol·dm^{-3} nitric acid solution. The nitric acid was in EXCESS. Assume that the volume remains constant.



50 cm^3 of the resulting solution was then titrated to neutralisation using 23,67 cm^3 of a standard 0,85 mol·dm^{-3} sodium carbonate solution.

7.4.1 Determine the amount (in mol) of nitric acid that was added to the KOH. (2)

7.4.2 Calculate the percentage purity of the KOH sample. (9)

[21]

TOTAL [150]

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^θ	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4\ dm^3{\cdot}mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^θ	273 K
Avogadro's constant	N_A	$6{,}023 \times 10^{23}\ mol^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR/OF $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{n_a}{n_b} = \frac{c_a V_a}{c_b V_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/ by 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ OR/*OF* $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ OR/*OF* $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

KEY/*SLEUTEL*

Atomic number
Atoomgetal

29
1,9 Cu
63,5

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Al 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cl 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tl 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															
				58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
				90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

TABLE 4A: STANDARD REDUCTION POTENSTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Increasing strength of oxidising agents/*Toenemende sterkte van oksideermiddels* ↑

Half-reactions/*Halfreaksies*			**E^θ (V)**
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 4e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$NO_3^- + 2H^+ + e$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	$\rightleftharpoons$	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	- 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels* ↓

TABLE 4B: STANDARD REDUCTION POTENSTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing strength of oxidising agents/*Toenemende sterkte van oksideermiddels*

Half-reactions/*Halfreaksies*			E^θ (V)
$Li^+ + e^-$	$\rightleftharpoons$	Li	− 3,05
$K^+ + e^-$	$\rightleftharpoons$	K	− 2,93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	- 2,92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	− 2,90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	− 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	− 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	− 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	− 2,36
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	− 1,66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	− 1,18
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	− 0,91
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	− 0,76
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	− 0,74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	− 0,44
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	− 0,40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	− 0,28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	− 0,27
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	− 0,14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	− 0,13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	− 0,06
$2H^+ + 2e^-$	$\rightleftharpoons$	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 4e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7\ H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5\ e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels*