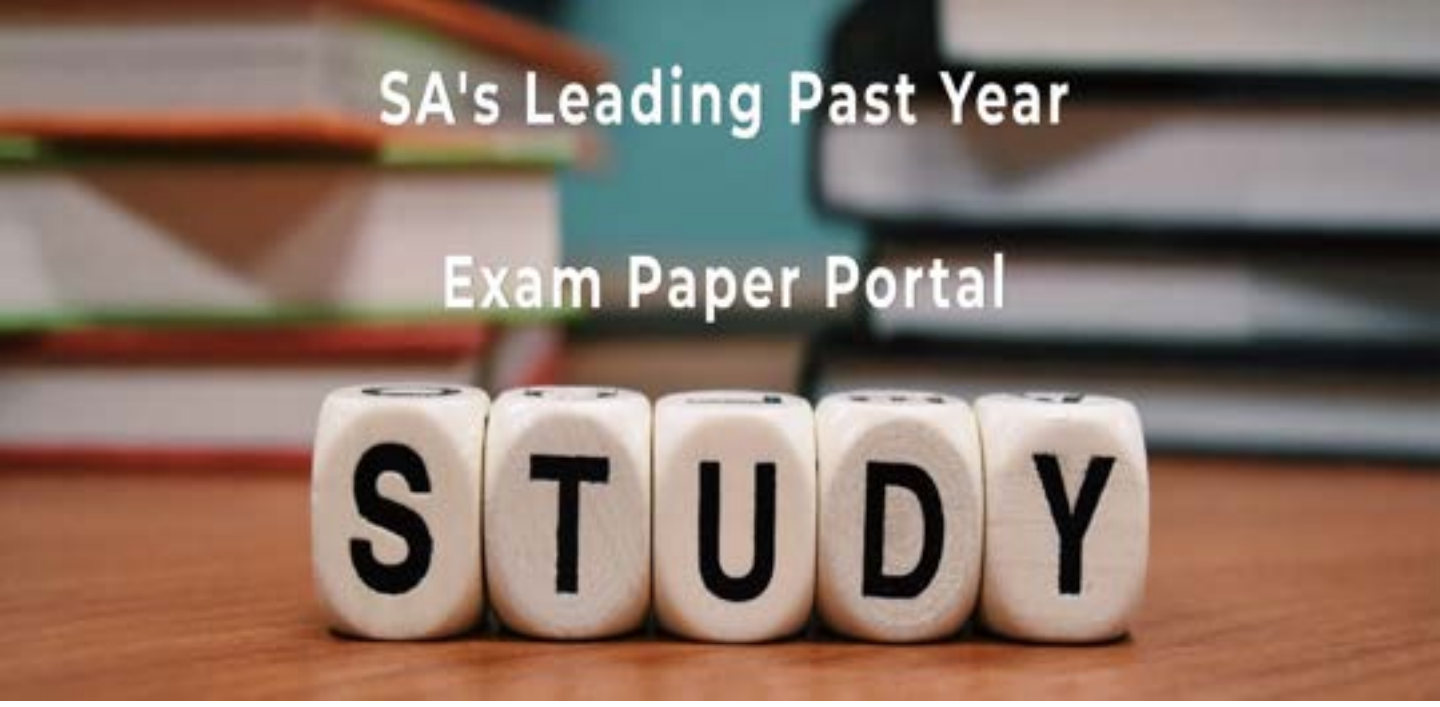

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GRADE 12

PHYSICAL SCIENCES: CHEMISTRY P2

JUNE 2021

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 4 data sheets.

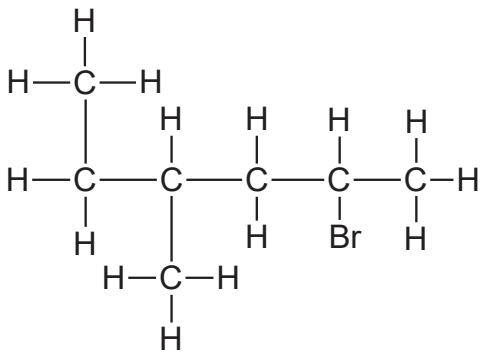
INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN 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.

OUESTION 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 The correct IUPAC name of the compound with the structural formula shown below, is …



A 1,2-dimethyl-4-bromopentane

B 2-bromo-4,5-dimethylpentane

C 4-methyl-2-bromohexane

D 2-bromo-4-methylhexane (2)

1.2 Which ONE of the formulae below represents an ALDEHYDE?

A $C_2H_4O_2$

B C_4H_8O

C $C_5H_{12}O$

D CH_2O_4 (2)

1.3 In which ONE of the following options are the four compounds arranged in order of DECREASING boiling points?

A	$CH_3CH_2CH_3$	CH_3CH_2CHO	$CH_3CH_2CH_2OH$	CH_3CH_2COOH
B	CH_3CH_2CHO	$CH_3CH_2CH_2OH$	$CH_3CH_2CH_3$	CH_3CH_2COOH
C	CH_3CH_2COOH	$CH_3CH_2CH_2OH$	CH_3CH_2CHO	$CH_3CH_2CH_3$
D	CH_3CH_2COOH	CH_3CH_2CHO	$CH_3CH_2CH_2OH$	$CH_3CH_2CH_3$

(2)

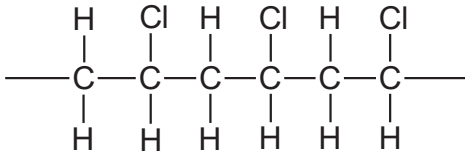
1.4 Refer to the flow diagram below.

The name of main product A as well as the type of reaction taking place are:

	MAIN PRODUCT A	TYPE OF REACTION
A	2-chlorobutane	Halogenation
B	2-chlorobutane	Hydrohalogenation
C	1-chlorobutane	Halogenation
D	1-chlorobutane	Hydrohalogenation

(2)

1.5 The following polymer is the result of addition polymerisation.



Which ONE of the following is the monomer of the above mentioned polymer?

A Ethene

B Propene

C Chloroethene

D Chloromethane (2)

1.6 The reaction for a saturated salt solution is shown below:

$$NaC\ell(s) \rightleftharpoons Na^{+}(aq) + C\ell^{-}(aq)$$

Which ONE of the following changes will favour the reverse reaction?

A Heat the solution

B Increase the pressure on the system

C Add concentrated hydrochloric acid (HCℓ).

D Bubble chlorine ($C\ell_2$) gas through the solution. (2)

1.7 Consider the chemical reaction represented by the equation below:

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

Which ONE of the following changes will increase the rate of production of $H_2(g)$?

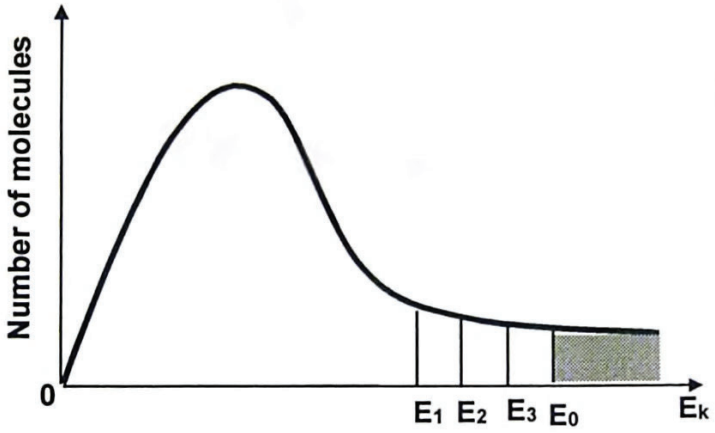
A Increase pressure

B Increase volume of $HC\ell(aq)$

C Decrease concentration of $HC\ell(aq)$

D Increase temperature (2)

1.8 THREE catalysts are used separately to increase the rate of a hypothetical reaction. In the diagram below, E_1, E_2 and E_3 represent the effect of each catalyst on the activation energy (E_0) for the reaction.



Which ONE of the following is the activation energy for the reaction with the highest rate?

A E_1

B E_2

C E_3

D E_0 (2)

1.9 If the concentration of a sodium hydroxide (NaOH) solution is 0,01 mol·dm^{-3}, then the OH^-(aq) concentration of the NaOH(aq) and the pH-value of the NaOH(aq) at 25 °C will be …

	[OH^-] (mol·dm^{-3})	**pH**
A	10^{-12}	12
B	10^{-12}	2
C	10^{-2}	12
D	10^{-2}	2

(2)

1.10 If base **X** is titrated against acid **Y**, the pH at the endpoint is 9.

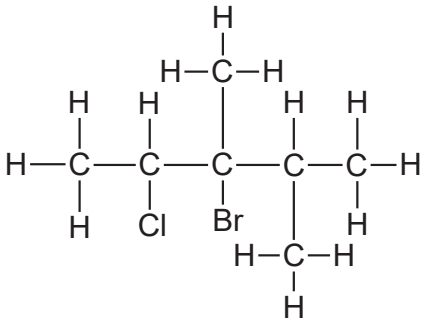
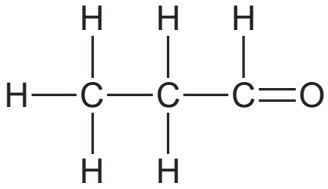
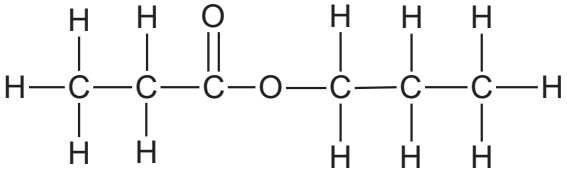
Which ONE of the following combinations CORRECTLY represents base **X** and acid **Y**?

	Base X	**Acid Y**
A	KOH	HNO_3
B	NaOH	CH_3COOH
C	NH_3	H_2SO_4
D	$NaHCO_3$	HCℓ

(2)
[20]

QUESTION 2 (Start on a new page)

Consider the following eight organic compounds represented by letters **A** to **H.**

A	Propanone	**B**	C_2H_4
C	$CH_3CH_2CH_2OH$	**D**	
E		**F**	CH_3COOH
G	2,2-dimethylpropane	**H**	

2.1 Write down the LETTER that represents the following:

2.1.1 A weak monoprotic acid. (1)

2.1.2 A CHAIN ISOMER of $CH_3(CH_2)_3CH_3$. (1)

2.1.3 A compound used as reactant in the preparation of compound **H**. (1)

2.2 Write down the:

2.2.1 Structural formula of the functional group of compound **A**. (2)

2.2.2 Name of the homologous series to which compound **F** belongs. (1)

2.2.3 IUPAC name of compound **H** (2)

2.2.4 IUPAC name of compound **D** (3)

2.3 Compound **C** is a primary alcohol

2.3.1 Define the term *primary alcohol*. (2)

2.3.2 Write down the STRUCTURAL FORMULA of the POSITIONAL isomer of compound **C**. (2)

2.4 Compound **B** is considered as *unsaturated*.

2.4.1 Give a reason why compound **B** is unsaturated. (1)

2.4.2 Write down the NAME of a solution that you can use in the laboratory to test whether compound **B** is unsaturated. (1)

2.4.3 What will be observed when this solution is added to compound **B**? (2)

2.4.4 Write down the IUPAC name of the product formed. (2)

[21]

QUESTION 3 (Start on a new page)

An experiment is conducted to determine the boiling point of organic compounds from different homologous series under the same conditions.

COMPOUND	NAME	MOLECULAR FORMULA
P	Hexane	C_6H_{14}
Q	2,3-dimethylbutane	C_6H_{14}
R	Methyl propanoate	$C_4H_8O_2$
S	Pentan-1-ol	$C_5H_{12}O$

Consider the boiling points of compounds **P** to **S** given in random order below and use them, where applicable, to answer the questions that follow.

79,8 ºC	68 ºC	138,5 ºC	57,9 ºC

3.1 Write down the:

3.1.1 Independent variable for this experiment (1)

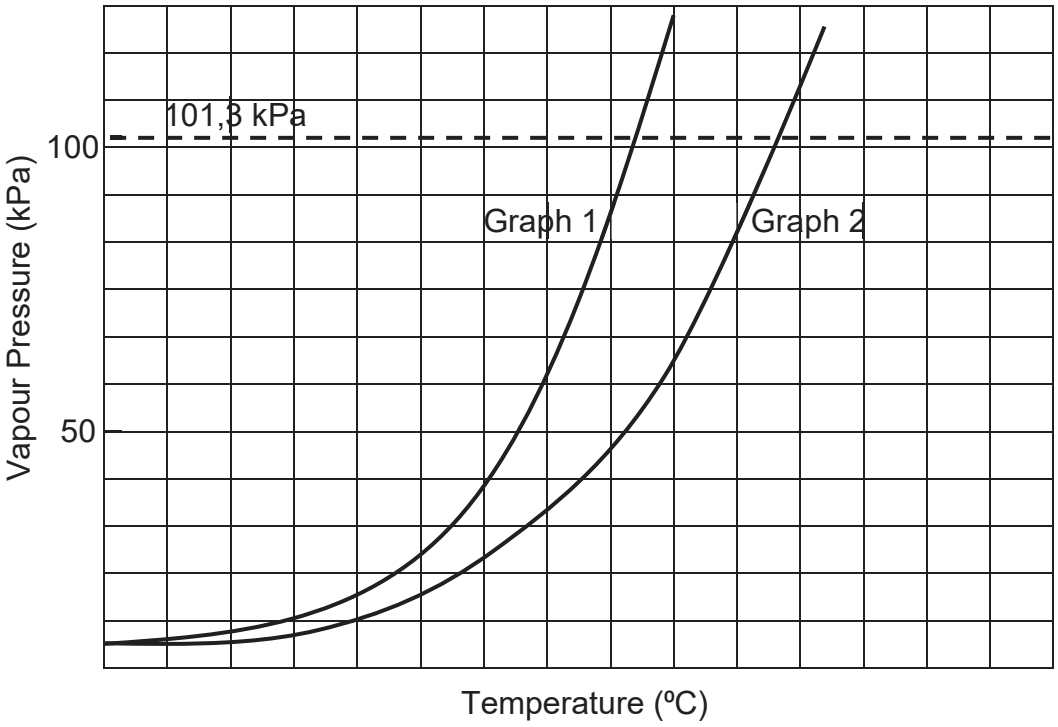
3.1.2 STRUCTURAL FORMULA of compound **R**. (2)

3.1.3 Boiling point of compound **R**. (1)

3.1.4 Boiling point of compound **S**. (1)

3.2 Explain the difference in boiling points between compounds **R** and **S**. (4)

3.3 The following graph shows the relationship between vapour pressure and temperature of compounds **P** and **Q.** The dotted line indicates the external atmospheric pressure.



3.3.1 Define the term *vapour pressure*. (2)

3.3.2 Using molecular formulae, write down the balanced equation for the complete combustion of compound **P**. (3)

3.3.3 Which ONE of the compounds **P** or **Q** is represented by GRAPH 2? (1)

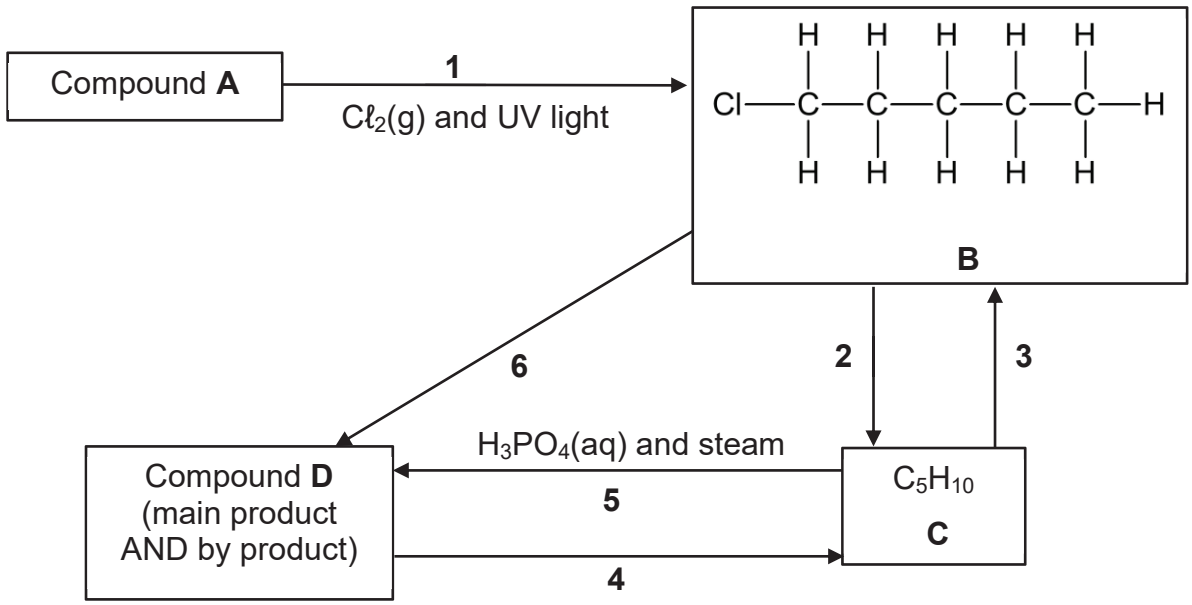
3.3.4 Fully explain the answer to QUESTION 3.3.3 (3)

3.3.5 Redraw graph 2 in your answer book. On the same set of axes sketch the curve that will be obtained for compound **S**. Label this curve **S.** (2)

[20]

QUESTION 4 (Start on a new page)

Consider the flow chart below showing different organic reactions, and answer the questions that follow. **A** to **D** are organic compounds, and **1** to **6** are organic reactions.



4.1 Compound **A** is a hydrocarbon

4.1.1 Define the term *hydrocarbon.* (2)

4.1.2 Write down the IUPAC name of compound **A**. (1)

4.2 Identify the TYPE of reaction for each of the following:

4.2.1 Reaction **1** (1)

4.2.2 Reaction **5** (1)

4.2.3 Reaction **6** (1)

4.3 Draw the structural formula of the main product for reaction **5** and write down its IUPAC name. (3)

4.4 Write down the type of addition reaction represented at reaction **3**. (1)

4.5 Write down the NUMBER of the reaction that would take place if the relevant organic compound was heated strongly in the presence of concentrated alcoholic potassium hydroxide. (1)

[11]

QUESTION 5: **(Start on a new page)**

Study the following chemical equation:

$$CO(g) + NO_2(g) \rightarrow CO_2(g) + NO(g) \qquad \Delta H = -60 kJ \cdot mol^{-1}$$

5.1 Use the above equation and draw a potential energy diagram. Label the specific reactants and products, as well as the activation energy and heat of reaction. (4)

5.2 Define the term *catalyst*. (2)

5.3 The following table shows two catalysts that can be used for this reaction and their corresponding activation energies.

Catalyst	Activation energy ($kJ \cdot mol^{-1}$)
Platinum catalyst	70,6
Osmium catalyst	104,6

Which catalyst, PLATINUM or OSMIUM will be more effective for this reaction? Use the collision theory to explain the answer. (4)
[10]

QUESTION 6: **(Start on a new page)**

A student investigates the reaction rate between magnesium and sulphuric acid. The balanced equation for the reaction that takes place is:

$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$

The student repeats the experiment a few times with different concentrations of sulphuric acid. All the other variables are kept constant.

The results are recorded in the table below:

Concentration of sulphuric acid ($mol \cdot dm^{-3}$)	Rate of reaction ($cm^3 \cdot s^{-1}$)
0,4	4,2
0,8	8,5
1,6	17,0

6.1 Formulate an investigative question for this investigation. (2)

6.2 Write down ONE variable that must be kept constant. (1)

6.3 What will be the effect on the reaction rate if lumps of magnesium are used (1)

instead of powered magnesium? Write only: INCREASE, DECREASE or REMAIN THE SAME.

6.4 Use the collision theory to explain the answer to QUESTION 6.3. (3)

6.5 What will be the effect on the rate of reaction if the temperature increases from 20°C to 30°C? Write only: INCREASE, DECREASE or REMAIN THE SAME. (1)

An experiment was conducted to investigate the rate of reaction between EXCESS calcium carbonate and dilute nitric acid. The balanced chemical equation for this reaction is given below.

$$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(\ell) + CO_2(g)$$

Flask A **Flask B**

4,5 g lump $CaCO_3(s)$

200 cm^3, 0,3 $mol \cdot dm^{-3}$ $HNO_3(aq)$ at 25°C

300 cm^3, 0,3 $mol \cdot dm^{-3}$ $HNO_3(aq)$ at 25°C

6.6 Calculate the volume of $CO_2(g)$ produced at STP in flask A. (4)

6.7 Use the answer in QUESTION 6.6 to calculate the rate of reaction in flask A for the first 20 s in ($dm^3 \cdot s^{-1}$) (3)

6.8 How will the rate of reaction in flask B compare to that in flask A? Choose from GREATER THAN A, LESS THAN A or EQUAL TO A. (1)

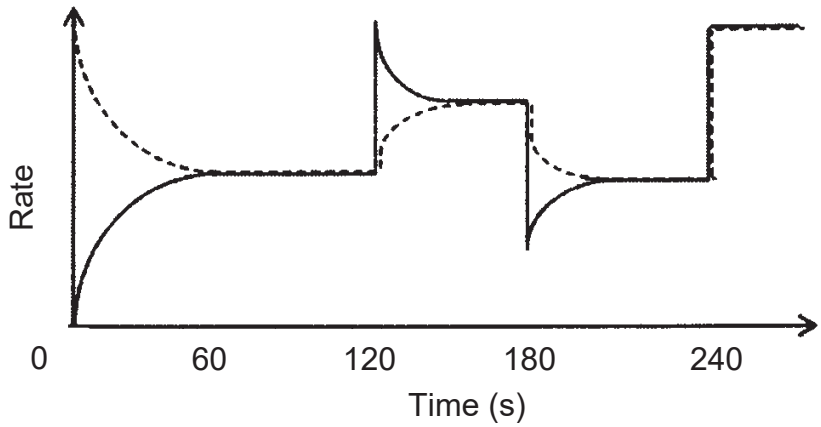
[16]

QUESTION 7: **(Start on a new page)**

Gas **A_2B** is introduced into a flask, which is then sealed , and allowed to reach dynamic chemical equilibrium at a certain temperature. The balanced chemical equation for the reaction is:

$$2A_2B(g) \rightleftharpoons 2A_2(g) + B_2(g)$$

The graph below shows the change in the rates of the forward and reverse reactions with time. The solid line represents the reverse reaction.



7.1 Define the term *dynamic equalibrium*. (2)

7.2 At t = 120 s the volume of the container is decreased, which leads to an increase in pressure.

7.2.1 The graph shows that at t = 120 s, both the forward and reverse reactions initially (immediately) increase at the same rate. Explain this observation. (2)

7.2.2 Which reaction is favoured between t = 120 s and t = 150 s? (FORWARD or REVERSE) (1)

7.2.3 Using Le Chatelier's Principle explain the answer to QUESTION 7.2.2. (2)

7.3 At t = 180 s the temperature in the container is decreased. Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Explain the answer. (3)

7.4 What change was made at t = 240 s? (1)

7.5 How does the consentration of A_2B change between t = 230 s and t = 250 s? Write only INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)

7.6 What will the effect be on the equilibrium constant (K_c) for …
(Write only INCREASE, DECREASE or NO EFFECT.)

7.6.1 The increase in pressure at t = 120 s. (1)

7.6.2 The decrease in temperature at t = 180 s. (1)

7.7 Initially 5,1 moles of gas A_2B are introduced into a reaction flask. The flask is then sealed and kept at a constant temperature. The gas A_2B decomposes as shown in the balanced chemical equation below:

$$2A_2B(g) \rightleftharpoons 2A_2(g) + B_2(g)$$

When dynamic chemical equilibrium is reached, 3,6 mol A_2 gas remained in the flask. The concentration of gas A_2 in the flask at equilibrium is 1,2 mol·dm^{-3}. Calculate the value of the equilibrium constant (K_c) for this reaction at this constant temperature. (7)

[23]

QUESTION 8: **(Start on a new page)**

8.1 A learner prepares a sulphuric acid (H_2SO_4) solution with a concentration of 0,25 mol·dm^{-3}.

8.1.1 Give a reason why sulpuric acid is referred to as a diprotic acid. (2)

8.1.2 Determine the pH of this solution. (4)

8.1.3 The learner takes 20 cm^3 of this solution and dilutes it to a solution with a concentration of 0,1 mol·dm^{-3}. Calculate the volume of water that was added to the initial 20 cm^3 solution. (4)

8.2 A few crystals of ammonium chloride ($NH_4C\ell$) are added to water in a test tube. The pH of the solution is less than 7.

Explain with the aid of a balanced equation why the pH is less than 7. (3)

8.3 The hydrogen sulphate ion (HSO_4^-) can act as both an acid and a base. It reacts with water according to the following balanced equation:

$$HSO_4^-(aq) + H_2O(\ell) \rightleftharpoons SO_4^{2-}(aq) + H_3O^+(aq)$$

8.3.1 Write down ONE word for a substance that can act as both an acid and a base. (1)

8.3.2 Write down the FORMULAE of two bases in the above reaction. (2)

8.4 A small amount of NaOH is added to pure water at a temperatures of 25 °C. How will this affect the:

(Choose between: INCREASES, DECREASES or NO CHANGE.)

8.4.1 K_w (1)

8.4.2 $[H_3O^+]$ (1)

8.5 A learner wants to determine the percentage magnesium oxide in a health tablet. She dissolves the tablet in 50 cm^3 of 0,8 $mol \cdot dm^{-3}$ hydrochloric acid solution. The balanced equation for the reaction is:

$$MgO(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2O(\ell)$$

8.5.1 Calculate the number of moles of acid present in 50 cm^3 of a 0,8 $mol \cdot dm^{-3}$ hydrochloric acid solution. (3)

Not all of the hydrochloric acid reacts. She titrates the excess hydrochloric acid with a sodium hydroxide solution. It takes 20 cm^3 of the 0,5 $mol \cdot dm^{-3}$ of sodium hydroxide solution to neutralise the excess hydrochloric acid. The hydrochloric acid and sodium hydroxide react as shown in the balanced equation below.

$$NaOH(aq) + HC\ell(aq) \rightarrow NaC\ell\ (aq) + H_2O(\ell)$$

8.5.2 The original mass of the tablet is 0,96 g. Calculate the percentage of magnesium oxide in the tablet. (8)

[29]

GRAND 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·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* $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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

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
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05

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

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
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	Aℓ	– 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(ℓ)	+ 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
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 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 oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
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