



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

## **NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: CHEMISTRY (P2)**

**NOVEMBER 2016**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 18 pages and 4 data sheets.**

## INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces 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 subquestions, 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

Various options are provided as possible answers to the following questions. Write down the question number (1.1–1.10), choose the answer and make a cross (X) over the letter (A–D) of your choice in the ANSWER BOOK.

EXAMPLE:

1.11      

A
---

B
---

C
---

<del>B</del>
--------------

1.1      In a chemical reaction an oxidising agent will ...

A      lose protons.

B      gain protons.

C      lose electrons.

D      gain electrons.

(2)

1.2      A catalyst is added to a reaction mixture at equilibrium.

Which ONE of the following statements about the effect of the catalyst is FALSE?

A      The rate of the forward reaction increases.

B      The rate of the reverse reaction increases.

C      The equilibrium position shifts to the right.

D      The equilibrium position remains unchanged.

(2)

1.3      What product will be formed when an alkene reacts with water vapour (H<sub>2</sub>O) in the presence of an acid catalyst?

A      Ester

B      Alkane

C      Alcohol

D      Aldehyde

(2)

1.4      Which ONE of the following represents a SUBSTITUTION REACTION?

A       $\text{CH}_2 = \text{CH}_2 + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br}$

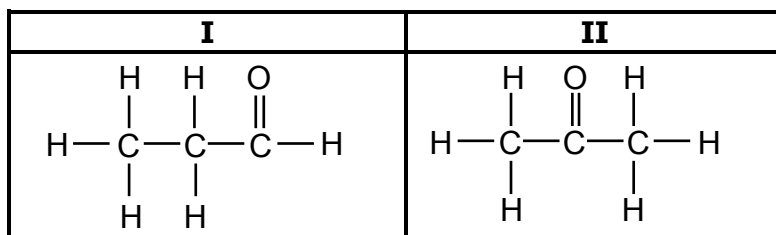
B       $\text{CH}_2 = \text{CH}_2 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{OH}$

C       $\text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{CH}_2 = \text{CH}_2 + \text{H}_2\text{O}$

D       $\text{CH}_3\text{CH}_2\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br} + \text{H}_2\text{O}$

(2)

1.5 Consider the two organic molecules **I** and **II** below.

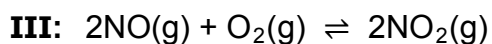
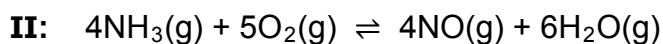
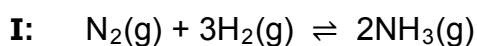


Which ONE of the following represents the homologous series to which compound **I** and compound **II** belong?

	<b>I</b>	<b>II</b>
A	Ketones	Alcohols
B	Aldehydes	Ketones
C	Aldehydes	Alcohols
D	Ketones	Aldehydes

(2)

1.6 Consider the balanced equations for three reactions represented below:



Which of the above reactions form(s) part of the Ostwald process?

A **I** only

B **II** only

C **III** only

D **II** and **III** only

(2)

1.7 Which ONE of the following pairs is NOT a conjugate acid-base pair?

A  $\text{H}_3\text{O}^+$  and  $\text{OH}^-$

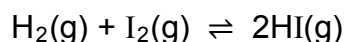
B  $\text{NH}_4^+$  and  $\text{NH}_3$

C  $\text{H}_2\text{PO}_4^-$  and  $\text{HPO}_4^{2-}$

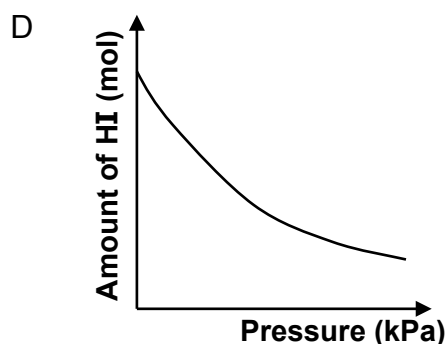
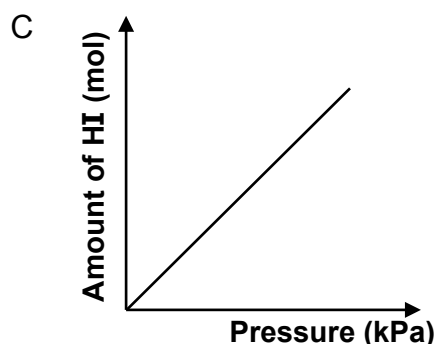
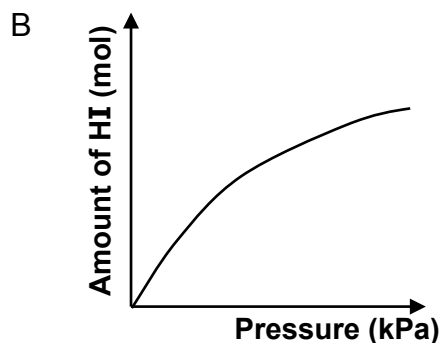
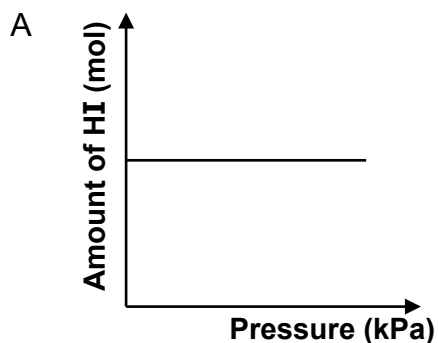
D  $\text{H}_2\text{CO}_3$  and  $\text{HCO}_3^-$

(2)

- 1.8 The reaction between hydrogen gas and iodine gas reaches equilibrium in a closed container according to the following balanced equation:



Which ONE of the graphs below shows the relationship between the amount of HI(g) at equilibrium and the pressure in the container at constant temperature?



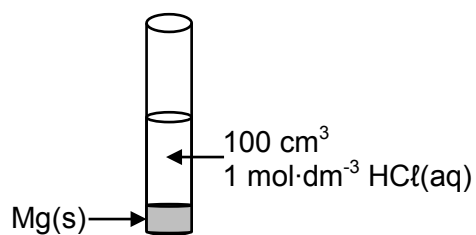
(2)

- 1.9 Which ONE of the equations below represents the half-reaction occurring at the CATHODE of an electrochemical cell that is used to electroplate an object?

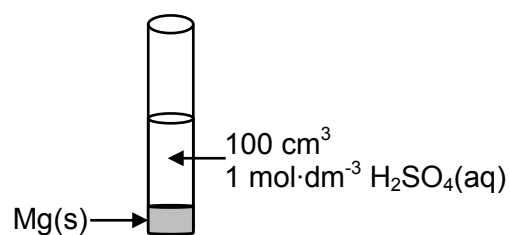
- A  $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$   
 B  $\text{Cr}^{3+} + 3\text{e}^- \rightarrow \text{Cr}$   
 C  $\text{Cr}^{3+} + \text{e}^- \rightarrow \text{Cr}^{2+}$   
 D  $\text{Cu}^{2+} + \text{e}^- \rightarrow \text{Cu}^+$

(2)

- 1.10 Equal amounts of magnesium (Mg) powder react respectively with equal volumes and equal concentrations of  $\text{HCl(aq)}$  and  $\text{H}_2\text{SO}_4\text{(aq)}$ , as shown below.



**Test tube X**



**Test tube Y**

The magnesium is in EXCESS.

Consider the following statements regarding these two reactions:

- I:** The initial rate of the reaction in test tube **X** equals the initial rate of the reaction in test tube **Y**.
- II:** After completion of the reactions, the mass of magnesium that remains in test tube **X** will be greater than that in test tube **Y**.
- III:** The amount of hydrogen gas formed in **X** is equal to the amount of hydrogen gas formed in **Y**.

Which of the above statements is/are TRUE?

- A **I** only
- B **II** only
- C **III** only
- D **I** and **III** only

(2)  
[20]

**QUESTION 2 (Start on a new page.)**

The letters **A** to **F** in the table below represent six organic compounds.

<b>A</b>	$  \begin{array}{c}  \text{H} \qquad \qquad \text{H} \\    \qquad \qquad   \\  \text{H}-\text{C}-\text{C}=\text{C}-\text{H} \\    \qquad \qquad   \\  \text{H} \qquad \qquad \text{H}-\text{C}-\text{H} \\    \\  \text{H}  \end{array}  $	<b>B</b>	Ethyl ethanoate
<b>C</b>	2,3-dibromo-3-methylpentane	<b>D</b>	Polyethene
<b>E</b>	$  \begin{array}{c}  \text{H} \qquad \text{O} \qquad \qquad \text{H} \\    \qquad    \qquad \qquad   \\  \text{H}-\text{C}-\text{C}-\text{O}-\text{C}-\text{H} \\    \qquad   \qquad \qquad   \\  \text{H} \qquad \text{H} \qquad \qquad \text{H}  \end{array}  $	<b>F</b>	$  \begin{array}{c}  \text{H} \qquad \text{H} \qquad \text{H} \qquad \text{O}-\text{H} \\    \qquad   \qquad   \qquad   \\  \text{H}-\text{C}-\text{C}-\text{C}-\text{C}=\text{O} \\    \qquad   \qquad   \\  \text{H} \qquad \text{H} \qquad \text{H}  \end{array}  $

2.1 Write down the LETTER that represents the following:

2.1.1 A hydrocarbon (1)

2.1.2 A functional isomer of compound **F** (1)

2.1.3 A compound which belongs to the same homologous series as compound **B** (1)

2.1.4 A plastic (1)

2.2 Write down the STRUCTURAL FORMULA of EACH of the following:

2.2.1 Compound **C** (3)

2.2.2 The acid used to prepare compound **B** (2)

2.2.3 The monomer used to make compound **D** (2)

2.3 Compound **A** reacts with an unknown reactant, **X**, to form 2-methylpropane.

Write down the:

2.3.1 NAME of reactant **X** (1)

2.3.2 Type of reaction that takes place (1)

**[13]**

**QUESTION 3 (Start on a new page.)**

The boiling points of three isomers are given in the table below.

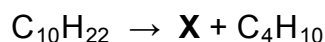
	ISOMERS	BOILING POINT (°C)
<b>A</b>	2,2-dimethylpropane	9
<b>B</b>	2-methylbutane	28
<b>C</b>	pentane	36

- 3.1 Define the term *structural isomer*. (2)
- 3.2 What type of isomers (POSITIONAL, CHAIN or FUNCTIONAL) are these three compounds? (1)
- 3.3 Explain the trend in the boiling points from compound **A** to compound **C**. (3)
- 3.4 Which ONE of the three compounds (**A**, **B** or **C**) has the highest vapour pressure? Refer to the data in the table to give a reason for the answer. (2)
- 3.5 Use MOLECULAR FORMULAE and write down a balanced equation for the complete combustion of compound **B**. (3)
- [11]**



**QUESTION 4 (Start on a new page.)**

Butane ( $C_4H_{10}$ ) is produced in industry by the THERMAL cracking of long-chain hydrocarbon molecules, as shown in the equation below. **X** represents an organic compound that is produced.



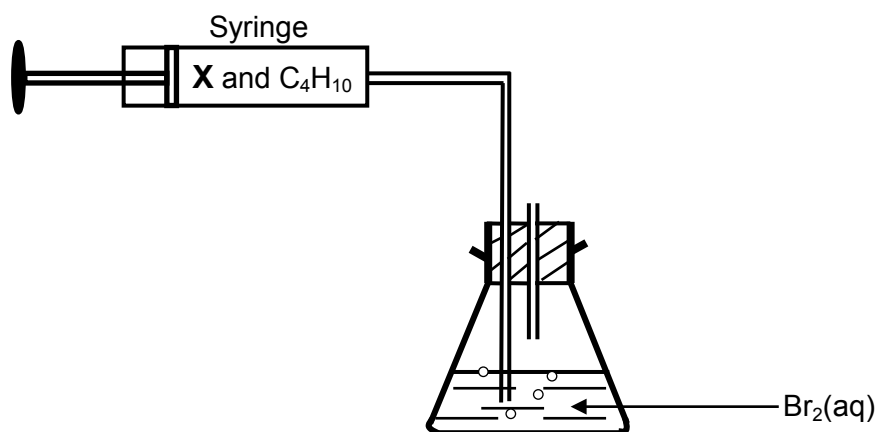
4.1 Write down:

4.1.1 ONE condition required for THERMAL cracking to take place (1)

4.1.2 The molecular formula of compound **X** (1)

4.1.3 The homologous series to which compound **X** belongs (1)

4.2 A mixture of the two gases, compound **X** and butane, is bubbled through bromine water,  $Br_2(aq)$ , in a conical flask, as illustrated below. THE REACTION IS CARRIED OUT IN A DARKENED ROOM.

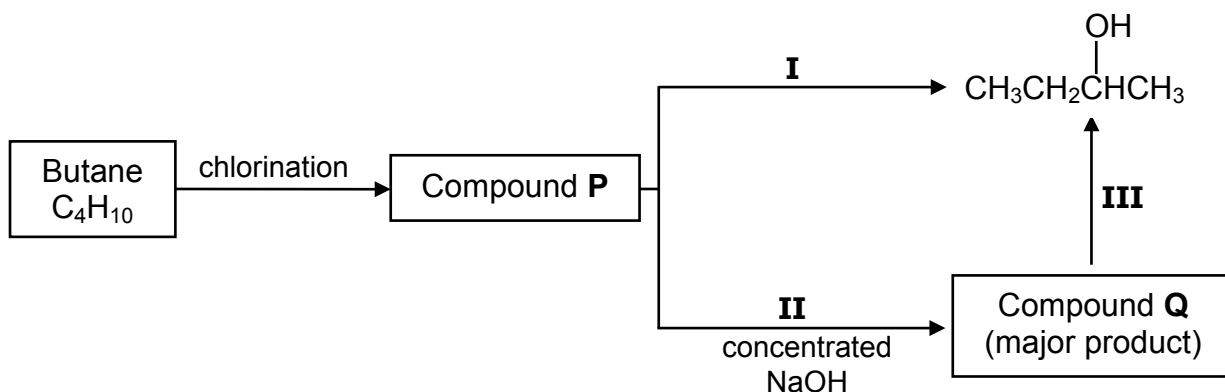


The colour of the bromine water changes from reddish brown to colourless when the mixture of the two gases is bubbled through it.

Which ONE of the gases (**X** or BUTANE) decolorises the bromine water? Explain the answer.

(4)

- 4.3 Study the flow diagram below, which represents various organic reactions, and answer the questions that follow.

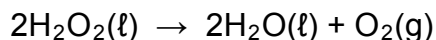


Write down the:

- 4.3.1 IUPAC name of compound **P** (2)
- 4.3.2 Type of reaction labelled **I** (1)
- 4.3.3 Structural formula of compound **Q** (2)
- 4.3.4 The type of addition reaction represented by reaction **III** (1)
- [13]

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

Hydrogen peroxide,  $\text{H}_2\text{O}_2$ , decomposes to produce water and oxygen according to the following balanced equation:



5.1 The activation energy ( $E_A$ ) for this reaction is 75 kJ and the heat of reaction ( $\Delta H$ ) is  $-196$  kJ.

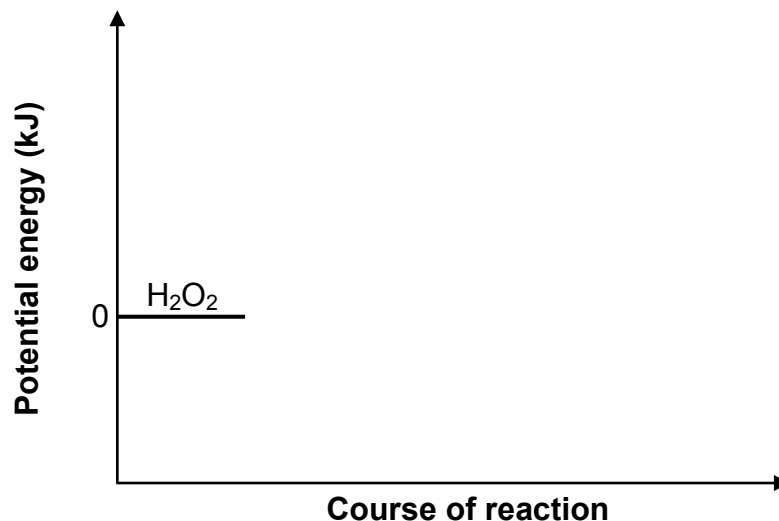
5.1.1 Define the term *activation energy*. (2)

5.1.2 Redraw the set of axes below in your ANSWER BOOK and then complete the potential energy diagram for this reaction.

Indicate the value of the potential energy of the following on the y-axis:

- Activated complex
- Products

(The graph does NOT have to be drawn to scale.)



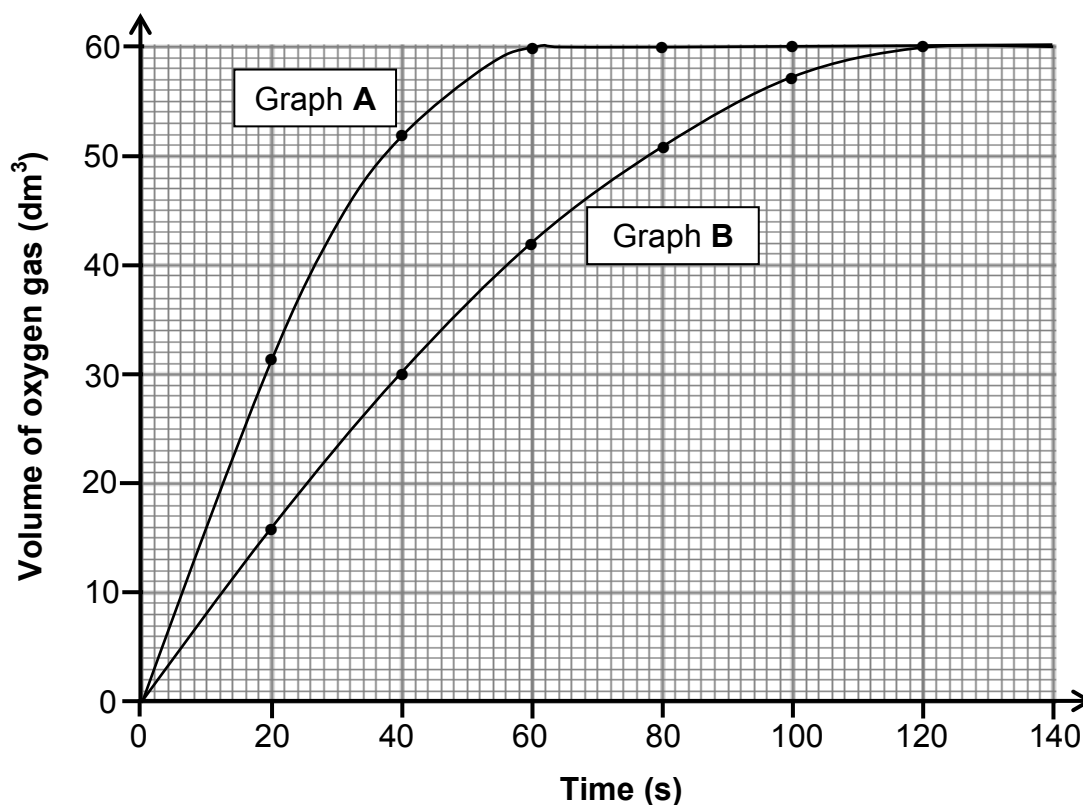
(3)

When powdered manganese dioxide is added to the reaction mixture, the rate of the reaction increases.

5.1.3 On the graph drawn for QUESTION 5.1.2, use broken lines to show the path of the reaction when the manganese dioxide is added. (2)

5.1.4 Use the collision theory to explain how manganese dioxide influences the rate of decomposition of hydrogen peroxide. (3)

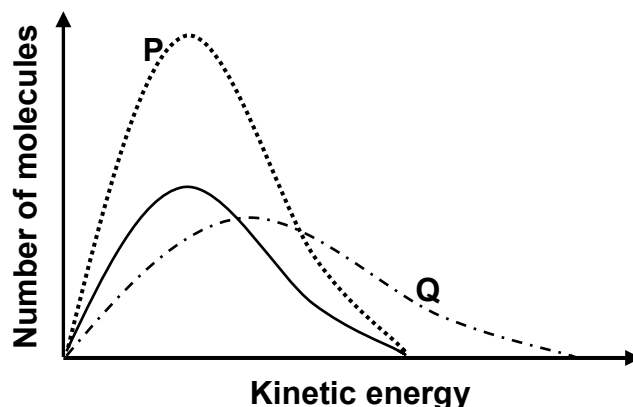
- 5.2 Graphs **A** and **B** below were obtained for the volume of oxygen produced over time under different conditions.



- 5.2.1 Calculate the average rate of the reaction (in  $\text{dm}^3 \cdot \text{s}^{-1}$ ) between  $t = 10 \text{ s}$  and  $t = 40 \text{ s}$  for graph **A**. (3)
- 5.2.2 Use the information in graph **A** to calculate the mass of hydrogen peroxide used in the reaction. Assume that all the hydrogen peroxide decomposed. Use  $24 \text{ dm}^3 \cdot \text{mol}^{-1}$  as the molar volume of oxygen. (4)
- 5.2.3 How does the mass of hydrogen peroxide used to obtain graph **B** compare to that used to obtain graph **A**? Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (1)

- 5.3 Three energy distribution curves for the oxygen gas produced under different conditions are shown in the graph below.

The curve with the solid line represents 1 mol of oxygen gas at 90 °C.

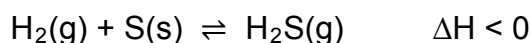


Choose the curve (**P** or **Q**) that best represents EACH of the following situations:

- 5.3.1 1 mol of oxygen gas produced at 120 °C (1)
- 5.3.2 2 moles of oxygen gas produced at 90 °C (1)
- [20]**

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

Hydrogen gas,  $\text{H}_2(\text{g})$ , reacts with sulphur powder,  $\text{S}(\text{s})$ , according to the following balanced equation:



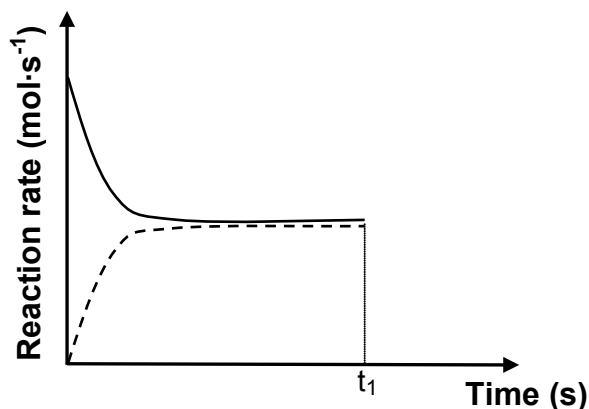
The system reaches equilibrium at 90 °C.

- 6.1 Define the term *chemical equilibrium*. (2)
- 6.2 How will EACH of the following changes affect the number of moles of  $\text{H}_2\text{S}(\text{g})$  at equilibrium?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

- 6.2.1 The addition of more sulphur (1)
- 6.2.2 An increase in temperature  
Use Le Chatelier's principle to explain the answer. (4)

6.3 The sketch graph below was obtained for the equilibrium mixture.



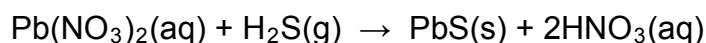
A catalyst is added to the equilibrium mixture at time  $t_1$ .

Redraw the graph above in your ANSWER BOOK. On the same set of axes, complete the graph showing the effect of the catalyst on the reaction rates.

(2)

Initially 0,16 mol  $\text{H}_2(\text{g})$  and excess  $\text{S}(\text{s})$  are sealed in a  $2 \text{ dm}^3$  container and the system is allowed to reach equilibrium at  $90^\circ\text{C}$ .

An exact amount of  $\text{Pb}(\text{NO}_3)_2$  solution is now added to the container so that ALL the  $\text{H}_2\text{S}(\text{g})$  present in the container at EQUILIBRIUM is converted to  $\text{PbS}(\text{s})$  according to the following balanced equation:



The mass of the  $\text{PbS}$  precipitate is 2,39 g.

6.4 Calculate the equilibrium constant  $K_c$  for the reaction  $\text{H}_2(\text{g}) + \text{S}(\text{s}) \rightleftharpoons \text{H}_2\text{S}(\text{g})$  at  $90^\circ\text{C}$ .

(9)

**[18]**

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

7.1 A learner dissolves ammonium chloride ( $\text{NH}_4\text{Cl}$ ) crystals in water and measures the pH of the solution.

7.1.1 Define the term *hydrolysis* of a salt. (2)

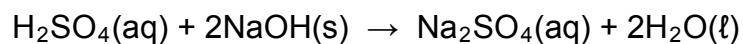
7.1.2 Will the pH of the solution be GREATER THAN, SMALLER THAN or EQUAL TO 7? Write a relevant equation to support your answer. (3)

7.2 A sulphuric acid solution is prepared by dissolving 7,35 g of  $\text{H}_2\text{SO}_4(\ell)$  in  $500 \text{ cm}^3$  of water.

7.2.1 Calculate the number of moles of  $\text{H}_2\text{SO}_4$  present in this solution. (2)

Sodium hydroxide ( $\text{NaOH}$ ) pellets are added to the  $500 \text{ cm}^3$   $\text{H}_2\text{SO}_4$  solution.

The balanced equation for the reaction is:

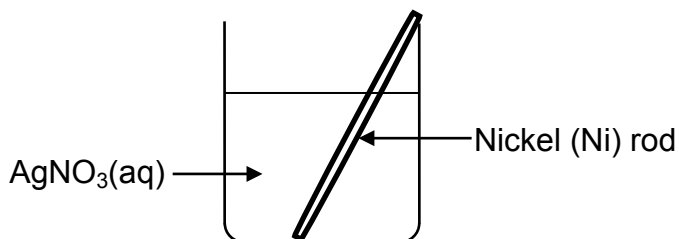


After completion of the reaction, the pH of the solution was found to be 1,3. Assume complete ionisation of  $\text{H}_2\text{SO}_4$ .

7.2.2 Calculate the mass of  $\text{NaOH}$  added to the  $\text{H}_2\text{SO}_4$  solution. Assume that the volume of the solution does not change. (9)  
**[16]**

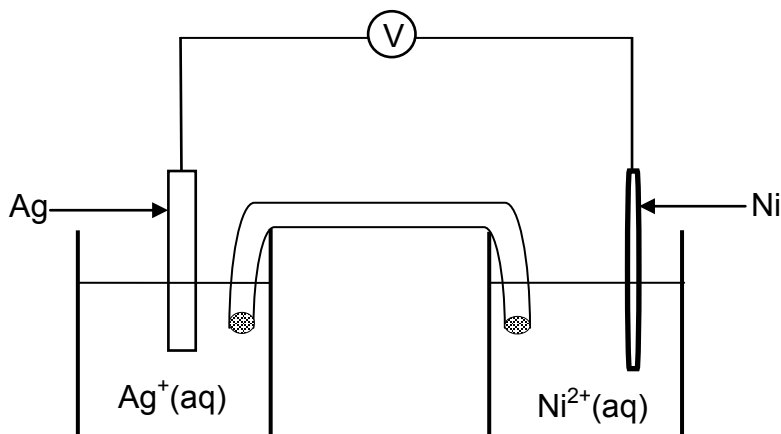
**QUESTION 8 (Start on a new page.)**

- 8.1 A nickel (Ni) rod is placed in a beaker containing a silver nitrate solution,  $\text{AgNO}_3(\text{aq})$  and a reaction takes place.



Write down the:

- 8.1.1 NAME or FORMULA of the electrolyte (1)
- 8.1.2 Oxidation half-reaction that takes place (2)
- 8.1.3 Balanced equation for the net (overall) redox reaction that takes place (3)
- 8.2 A galvanic cell is now set up using a nickel half-cell and a silver half-cell.



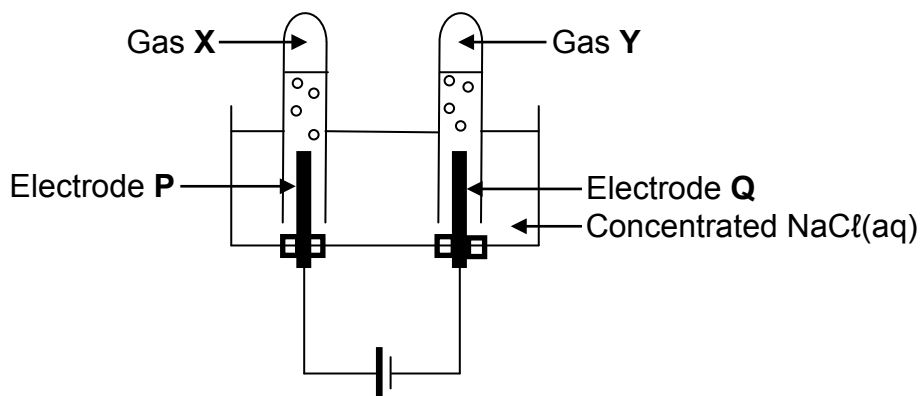
- 8.2.1 Which electrode (**Ni** or **Ag**) must be connected to the negative terminal of the voltmeter? Give a reason for the answer. (2)
- 8.2.2 Write down the cell notation for the galvanic cell above. (3)
- 8.2.3 Calculate the initial reading on the voltmeter if the cell functions under standard conditions. (4)
- 8.2.4 How will the voltmeter reading in QUESTION 8.2.3 be affected if the concentration of the silver ions is increased? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

**[16]**



**QUESTION 9 (Start on a new page.)**

In the electrochemical cell below, carbon electrodes are used during the electrolysis of a concentrated sodium chloride solution.



The balanced equation for the net (overall) cell reaction is:

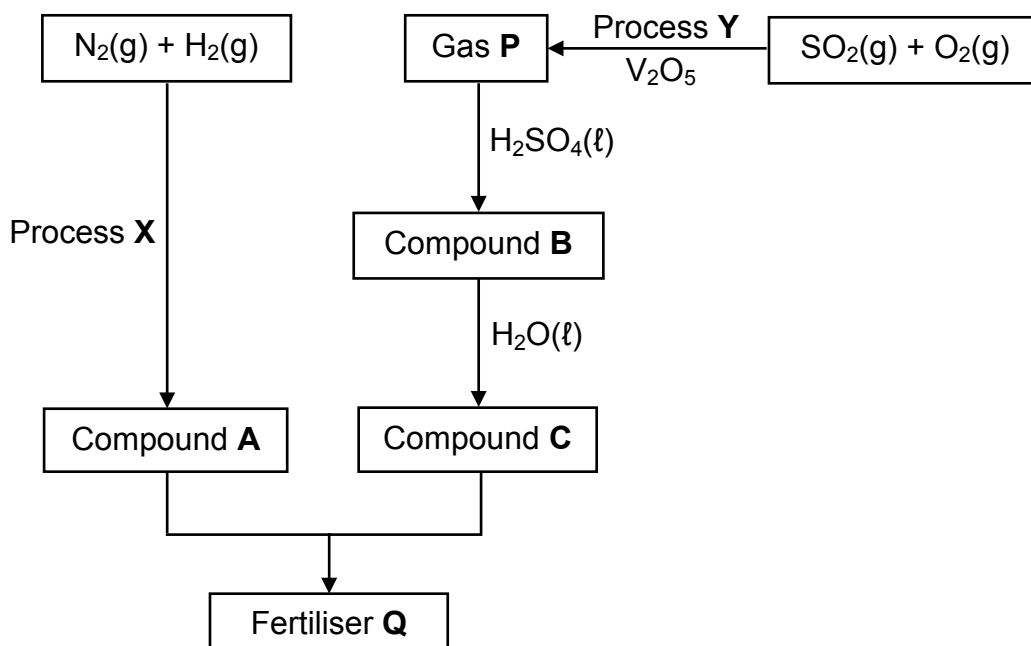


- 9.1 Is the reaction EXOTHERMIC or ENDOTHERMIC? (1)
- 9.2 Is electrode **P** the ANODE or the CATHODE? Give a reason for the answer. (2)
- 9.3 Write down the:
- 9.3.1 NAME or FORMULA of gas **X** (1)
- 9.3.2 NAME or FORMULA of gas **Y** (1)
- 9.3.3 Reduction half-reaction (2)
- 9.4 Is the solution in the cell ACIDIC or ALKALINE (BASIC) after completion of the reaction? Give a reason for the answer. (2)

**[9]**

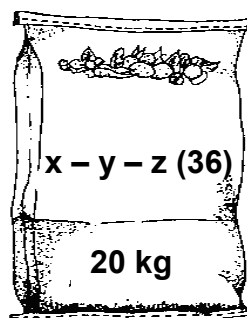
**QUESTION 10 (Start on a new page.)**

- 10.1 The flow diagram below shows the processes involved in the industrial preparation of fertiliser **Q**.



Write down the:

- 10.1.1 Name of process **X** (1)
- 10.1.2 Name of process **Y** (1)
- 10.1.3 NAME or FORMULA of gas **P** (1)
- 10.1.4 Balanced equation for the formation of compound **B** (3)
- 10.1.5 Balanced equation for the formation of fertiliser **Q** (4)
- 10.2 The diagram below shows a bag of NPK fertiliser of which the NPK ratio is unknown. It is found that the mass of nitrogen in the bag is 4,11 kg and the mass of phosphorus is 0,51 kg.



Calculate the NPK ratio of the fertiliser.

(4)  
[14]

**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 <i>Standaarddruk</i>	$p^{\theta}$	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molêre gasvolume by STD</i>	$V_m$	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature <i>Standaardtemperatuur</i>	$T^{\theta}$	$273 \text{ K}$
Charge on electron <i>Lading op elektron</i>	$e$	$-1,6 \times 10^{-19} \text{ C}$
Avogadro's constant <i>Avogadro-konstante</i>	$N_A$	$6,02 \times 10^{23} \text{ mol}^{-1}$

**TABLE 2: FORMULAE/TABEL 2: FORMULES**

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14} \text{ at/by } 298 \text{ K}$	
$E_{\text{cell}}^{\theta} = E_{\text{cathode}}^{\theta} - E_{\text{anode}}^{\theta} / E_{\text{sel}}^{\theta} = E_{\text{katode}}^{\theta} - E_{\text{anode}}^{\theta}$ or/of $E_{\text{cell}}^{\theta} = E_{\text{reduction}}^{\theta} - E_{\text{oxidation}}^{\theta} / E_{\text{sel}}^{\theta} = E_{\text{reduksie}}^{\theta} - E_{\text{oksidasie}}^{\theta}$ or/of $E_{\text{cell}}^{\theta} = E_{\text{oxidising agent}}^{\theta} - E_{\text{reducing agent}}^{\theta} / E_{\text{sel}}^{\theta} = E_{\text{oksideermiddel}}^{\theta} - E_{\text{reduseermiddel}}^{\theta}$	

**TABLE 3: THE PERIODIC TABLE OF ELEMENTS**  
**TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE**

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

**KEY/SLEUTEL**

Atomic number  
*Atoomgetal*

Electronegativity  
*Elektronegatiwiteit*

Symbol  
*Simbool*

Approximate relative atomic mass  
*Benaderde relatiewe atoommassa*

**TABLE 4A: STANDARD REDUCTION POTENTIALS**  
**TABEL 4A: STANDAARDREDUKSIEPOTENSIALE**

Increasing oxidising ability/Toenemende oksiderende vermoë

Half-reactions/Halfreaksies	E° (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
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 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
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(l)$	+ 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
<b><math>2H^+ + 2e^- \rightleftharpoons H_2(g)</math></b>	<b>0,00</b>
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	- 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
$Al^{3+} + 3e^- \rightleftharpoons Al$	- 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 reducing ability/Toenemende reducerende vermoë

**TABLE 4B: STANDARD REDUCTION POTENTIALS**  
**TABEL 4B: STANDAARDREDUKSIEPOTENSIALE**

Increasing oxidising ability/Toenemende oksiderende vermoë

Half-reactions/Halfreaksies	$E^{\circ}$ (V)
$\text{Li}^{+} + \text{e}^{-} \rightleftharpoons \text{Li}$	- 3,05
$\text{K}^{+} + \text{e}^{-} \rightleftharpoons \text{K}$	- 2,93
$\text{Cs}^{+} + \text{e}^{-} \rightleftharpoons \text{Cs}$	- 2,92
$\text{Ba}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Ba}$	- 2,90
$\text{Sr}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Sr}$	- 2,89
$\text{Ca}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Ca}$	- 2,87
$\text{Na}^{+} + \text{e}^{-} \rightleftharpoons \text{Na}$	- 2,71
$\text{Mg}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Mg}$	- 2,36
$\text{Al}^{3+} + 3\text{e}^{-} \rightleftharpoons \text{Al}$	- 1,66
$\text{Mn}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Mn}$	- 1,18
$\text{Cr}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Cr}$	- 0,91
$2\text{H}_2\text{O} + 2\text{e}^{-} \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^{-}$	- 0,83
$\text{Zn}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Zn}$	- 0,76
$\text{Cr}^{3+} + 3\text{e}^{-} \rightleftharpoons \text{Cr}$	- 0,74
$\text{Fe}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Fe}$	- 0,44
$\text{Cr}^{3+} + \text{e}^{-} \rightleftharpoons \text{Cr}^{2+}$	- 0,41
$\text{Cd}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Cd}$	- 0,40
$\text{Co}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Co}$	- 0,28
$\text{Ni}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Ni}$	- 0,27
$\text{Sn}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Sn}$	- 0,14
$\text{Pb}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Pb}$	- 0,13
$\text{Fe}^{3+} + 3\text{e}^{-} \rightleftharpoons \text{Fe}$	- 0,06
$2\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons \text{H}_2(\text{g})$	<b>0,00</b>
$\text{S} + 2\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+ 0,14
$\text{Sn}^{4+} + 2\text{e}^{-} \rightleftharpoons \text{Sn}^{2+}$	+ 0,15
$\text{Cu}^{2+} + \text{e}^{-} \rightleftharpoons \text{Cu}^{+}$	+ 0,16
$\text{SO}_4^{2-} + 4\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+ 0,17
$\text{Cu}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Cu}$	+ 0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^{-} \rightleftharpoons 4\text{OH}^{-}$	+ 0,40
$\text{SO}_2 + 4\text{H}^{+} + 4\text{e}^{-} \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+ 0,45
$\text{Cu}^{+} + \text{e}^{-} \rightleftharpoons \text{Cu}$	+ 0,52
$\text{I}_2 + 2\text{e}^{-} \rightleftharpoons 2\text{I}^{-}$	+ 0,54
$\text{O}_2(\text{g}) + 2\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons \text{H}_2\text{O}_2$	+ 0,68
$\text{Fe}^{3+} + \text{e}^{-} \rightleftharpoons \text{Fe}^{2+}$	+ 0,77
$\text{NO}_3^{-} + 2\text{H}^{+} + \text{e}^{-} \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+ 0,80
$\text{Ag}^{+} + \text{e}^{-} \rightleftharpoons \text{Ag}$	+ 0,80
$\text{Hg}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Hg}(\ell)$	+ 0,85
$\text{NO}_3^{-} + 4\text{H}^{+} + 3\text{e}^{-} \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+ 0,96
$\text{Br}_2(\ell) + 2\text{e}^{-} \rightleftharpoons 2\text{Br}^{-}$	+ 1,07
$\text{Pt}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Pt}$	+ 1,20
$\text{MnO}_2 + 4\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+ 1,23
$\text{O}_2(\text{g}) + 4\text{H}^{+} + 4\text{e}^{-} \rightleftharpoons 2\text{H}_2\text{O}$	+ 1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^{+} + 6\text{e}^{-} \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+ 1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^{-} \rightleftharpoons 2\text{Cl}^{-}$	+ 1,36
$\text{MnO}_4^{-} + 8\text{H}^{+} + 5\text{e}^{-} \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+ 1,51
$\text{H}_2\text{O}_2 + 2\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons 2\text{H}_2\text{O}$	+ 1,77
$\text{Co}^{3+} + \text{e}^{-} \rightleftharpoons \text{Co}^{2+}$	+ 1,81
$\text{F}_2(\text{g}) + 2\text{e}^{-} \rightleftharpoons 2\text{F}^{-}$	+ 2,87

Increasing reducing ability/Toenemende reduserende vermoë



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL  
SENIOR CERTIFICATE  
NASIONALE  
SENIOR SERTIFIKAAT**

**GRADE/GRAAD 12**

**PHYSICAL SCIENCES: CHEMISTRY (P2)  
FISIESE WETENSKAPPE: CHEMIE (V2)**

**NOVEMBER 2016**

**MEMORANDUM**

**MARKS/PUNTE: 150**

**This memorandum consists of 22 pages.  
*Hierdie memorandum bestaan uit 22 bladsye.***

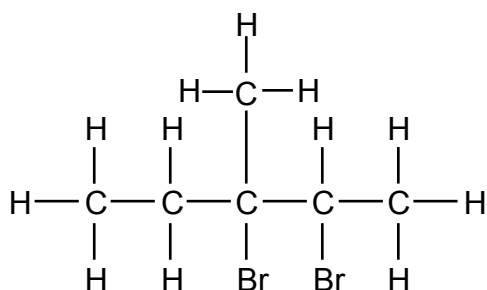
### QUESTION 1/VRAAG 1

- 1.1 D ✓✓ (2)
- 1.2 C ✓✓ (2)
- 1.3 C ✓✓ (2)
- 1.4 D ✓✓ (2)
- 1.5 B ✓✓ (2)
- 1.6 D ✓✓ (2)
- 1.7 A ✓✓ (2)
- 1.8 A ✓✓ (2)
- 1.9 B ✓✓ (2)
- 1.10 B ✓✓ (2)
- [20]**

### QUESTION 2/VRAAG 2

- 2.1
- 2.1.1 A **OR/OF** D ✓ (1)
- 2.1.2 B ✓ (1)
- 2.1.3 E ✓ (1)
- 2.1.4 D ✓ (1)

2.2  
 2.2.1



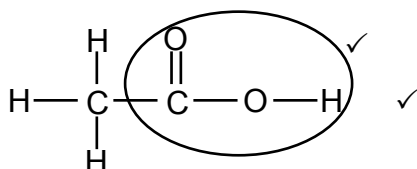
#### Marking criteria/Nasienriglyne:

- Five C atoms in longest chain. ✓  
*Vyf C-atome in langste ketting.*
- Two Br and one methyl substituents. ✓  
*Twee Br- en een metielsubstituente.*
- Whole structure correct. ✓  
*Hele struktuur korrek.*

(3)



2.2.2



**Marking criteria/Nasienriglyne:**

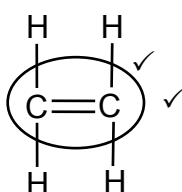
- Whole structure correct:  
*Hele struktuur korrek:*  $\frac{2}{2}$
- Only functional group correct:/Slegs funksionele groep korrek: Max/Maks.:  $\frac{1}{2}$
- Accept -OH as condensed.  
*Aanvaar -OH as gekondenseerd.*

**IF/INDIEN:**

More than one functional group/Meer as een funksionele groep  $\frac{0}{2}$

(2)

2.2.3



**Marking criteria/Nasienriglyne:**

- Whole structure correct:/Hele struktuur korrek:  $\frac{2}{2}$
- Only functional group correct/Slegs funksionele groep korrek Max:  $\frac{1}{2}$

**IF/INDIEN:**

More than one functional group/Meer as een funksionele groep  $\frac{0}{2}$

(2)

2.3

2.3.1 Hydrogen (gas)/Waterstof(gas) ✓

(1)

2.3.2 Addition / Hydrogenation ✓  
 Addisie / Hidrogenasie / Hidrogenering

(1)  
**[13]**

**QUESTION 3/VRAAG 3**

3.1 Compounds with the same molecular formula ✓ but different structural formulae. ✓ / Verbindings met dieselfde molekulêre formule maar verskillende struktuurformules.

(2)

3.2 Chain/Ketting ✓

(1)

3.3 **From A to C/Van A na C:**

• **Structure/Struktuur:**

Less branched / less compact / less spherical/longer chain length / larger surface area (over which intermolecular forces act). ✓

Minder vertak / minder kompak / minder sferies / langer kettinglengte / groter oppervlak (waaroor intermolekulêre kragte werk).

• **Intermolecular forces/Intermolekulêre kragte:**

Stronger / more intermolecular forces / Van der Waals forces / London forces / dispersion forces.

Sterker / meer intermolekulêre kragte / Van der Waalskragte / London-kragte / dispersiekragte. ✓

• **Energy/Energie:**

More energy needed to overcome or break intermolecular forces / Van der Waals forces. ✓

Meer energie benodig om intermolekulêre kragte / Van der Waalskragte / dispersiekragte / London-kragte te oorkom.

**OR/OF**

**From C to A/Van C na A:**

• **Structure/Struktuur:**

More branched / more compact / more spherical / smaller surface area (over which intermolecular forces act). ✓

Meer vertak / meer kompak / meer sferies / kleiner oppervlak (waaroor intermolekulêre kragte werk).

• **Intermolecular forces/Intermolekulêre kragte:**

Weaker / less intermolecular forces / Van der Waals forces / London forces / dispersion forces. ✓

Swakker/minder intermolekulêre kragte / Van der Waalskragte / Londonkragte / dispersiekragte.

**Energy/Energie:**

Less energy needed to overcome or break intermolecular forces / Van der Waals forces. ✓

Minder energie benodig om intermolekulêre kragte / Van der Waalskragte/ dispersiekragte / Londonkragte te oorkom.

(3)

3.4 A / 2,2-dimethylpropane / 2,2-dimetielpropaan ✓



Lowest boiling point. / Laagste kookpunt. ✓

(2)

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

**Notes/Aantekeninge:**

- Reactants ✓ Products ✓ Balancing ✓  
 Reaktanse Produkte Balansering
- Ignore double arrows and phases. / Ignoreer dubbelpyle en fases.
- Marking rule 6.3.10/Nasienreël 6.3.10.
- If condensed structural formulae used: / Indien gekondenseerde struktuur-formules gebruik: Max/Maks.  $\frac{2}{3}$

(3)

**[11]**

# QUESTION 4/VRAAG 4

4.1

4.1.1 High temperature / heat / high energy / high pressure ✓  
*Hoë temperatuur / hitte / hoë energie / hoë druk* (1)

4.1.2  $C_6H_{12}$  ✓

## Accept/Aanvaar:

Condensed structural formula and structural formula.

*Gekondenseerde struktuurformule en struktuurformule.*

E.g./Bv:  $CH_3CH_2CH_2CH_2CHCH_2$

(1)

4.1.3 Alkenes/Alkene ✓ (1)

4.2 X /  $C_6H_{12}$  / Alkene / Alkeen / Hexene / Hekseen ✓

## OPTION 1/OPSIE 1

- X is an alkene / has a double bond / unsaturated. ✓  
*X is 'n alkeen / het 'n dubbelbinding / onversadig.*
- X can undergo addition. ✓  
*X ondergaan addisie.*
- X will react without light / heat / is more reactive. ✓  
*X sal sonder lig / hitte reageer / is meer reaktief.*

## OPTION 2/OPSIE 2

- Butane is an alkane **OR** butane is saturated. ✓  
*Butaan is 'n alkaan **OF** butaan is versadig.*
- Butane can only undergo substitution. ✓  
*Butaan kan slegs substitusie ondergaan.*
- Butane will only react in the presence of light / heat **OR** butane is less reactive. ✓  
*Butaan sal slegs in die teenwoordigheid van lig / hitte reageer **OF** butaan is minder reaktief.*

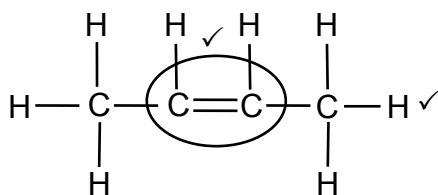
(4)

4.3

4.3.1 2-chloro✓ butane ✓  
*2-chlorobutaan* (2)

4.3.2 Substitution / Hydrolysis ✓  
*Substitusie / Hidrolise* (1)

4.3.3



**Marking criteria/Nasienriglyne:**

- Whole structure correct/*Hele struktuur korrek*:  $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek*:  $\frac{1}{2}$

**IF/INDIEN:**

More than one functional group/*Meer as een funksionele groep*

$\frac{0}{2}$

4.3.4 Hydration / *Hidrasie / Hidratering* ✓

(1)  
[13]

**QUESTION 5/VRAAG 5**

5.1

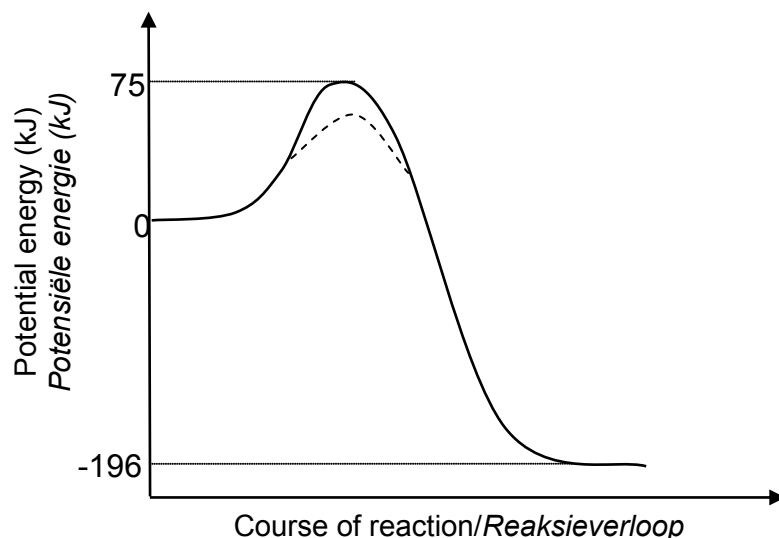
5.1.1 The minimum energy needed for a reaction to take place. ✓✓  
*Die minimum energie benodig vir 'n reaksie om plaas te vind.*

**OR/OF**

Minimum energy needed to form the activated complex./ *Minimum energie nodig om die geaktiveerde kompleks te vorm.*

(2)

5.1.2



<b>Marking criteria/Nasienriglyne:</b>	
Shape of curve for exothermic reaction as shown. <i>Vorme van kurwe vir eksotermiese reaksie soos getoon.</i>	✓
Energy of activated complex shown as 75 kJ in line with the peak. <i>Energie van geaktiveerde kompleks aangetoon as 75 kJ in lyn met die piek.</i>	✓
Energy of products shown as - 196 kJ below the zero. <i>Energie van produkte getoon as - 196 kJ onderkant die nulpunt.</i>	✓
<b>IF/INDIEN:</b> Wrong shape, e.g. straight line./ <i>Verkeerde vorm bv. reguitlyn.</i>	$\frac{0}{3}$

(3)

5.1.3 **Marking criteria/Nasienriglyne**

- Dotted line (---) on graph in QUESTION 5.1.2 showing lower energy for activated complex. ✓  
*Stippellyn (---) op grafiek in VRAAG 5.1.2 wat laer energie vir geaktiveerde kompleks toon.*
- Dotted curve starts at/above energy of reactants and ends at/above energy of products on the inside of the original curve. ✓  
*Stippellyn kurwe begin by/bokant energie van reaktanse en eindig by/bokant energie van produkte aan die binnekant van die oorspronklike kurwe.*

**Note/Aantekening:**

Allocate marks only if curve for either exothermic or endothermic reaction drawn in QUESTION 5.1.2.

*Ken punte slegs toe indien kurwe vir endotermiese of eksotermiese reaksie in VRAAG 5.1.2 geteken is.*

(2)

- 5.1.4
- A catalyst provides an alternative pathway of lower activation energy. ✓  
*'n Katalisator voorsien 'n alternatiewe pad van laer aktiveringsenergie.*

- More molecules have sufficient / enough (kinetic) energy. ✓  
*Meer molekule het voldoende / genoeg (kinetiese) energie.*

**OR/OF**

More molecules have kinetic energy equal to or greater than the activation energy.

*Meer molekule het kinetiese energie gelyk aan of groter as die aktiveringsenergie.*

- More effective collisions per unit time / second. ✓  
*Meer effektiewe botsings per eenheidstyd / sekonde.*

**OR/OF**

Rate / frequency of effective collisions increases.

*Tempo / frekwensie van effektiewe botsings neem toe.*

(3)

5.2

5.2.1

$$\begin{aligned}\text{Ave rate/Gem. tempo} &= \frac{\Delta V}{\Delta t} \\ &= \frac{52 - 16}{40 - 10} \checkmark \\ &= 1,2 \text{ (dm}^3 \cdot \text{s}^{-1}) \checkmark\end{aligned}$$

**Accept/Aanvaar:**

- Volume range/gebied:  
16 to/tot 17 cm<sup>3</sup>
- Answer range/Antwoordgebied:  
1,167 to 1,2 dm<sup>3</sup>·s<sup>-1</sup>

(3)

5.2.2

**Marking criteria/Nasienriglyne:**

- $V(O_2) = 60 \text{ dm}^3$  AND/EN divide volume by 24./deel volume deur 24 ✓
- Use ratio/Gebruik verhouding:  $n(H_2O_2) = 2n(O_2) = 1:2$  ✓
- Use  $34 \text{ g} \cdot \text{mol}^{-1}$  in  $n = \frac{m}{M}$  or in ratio calculation. ✓

*Gebruik  $34 \text{ g} \cdot \text{mol}^{-1}$  in  $n = \frac{m}{M}$  of in verhoudingsberekening.*

- Final answer/Finale antwoord: 170 g ✓

**OPTION 1/OPSIE 1**

$$\begin{aligned} n(O_2) &= \frac{V}{V_M} \\ &= \frac{60}{24} \checkmark \\ &= 2,5 \text{ mol} \\ n(H_2O_2) &= 2n(O_2) \\ &= 2(2,5) \checkmark \\ &= 5 \text{ mol} \\ n(H_2O_2) &= \frac{m}{M} \\ \therefore 5 &= \frac{m}{34} \checkmark \\ \therefore m &= 170 \text{ g} \checkmark \end{aligned}$$

**OPTION 2/OPSIE 2**

$$\begin{aligned} 24 \text{ dm}^3 &: 1 \text{ mol} \\ 60 \text{ dm}^3 &: 2,5 \text{ mol} \checkmark \\ n(H_2O_2) &= 2n(O_2) \\ &= 2(2,5) \checkmark \\ &= 5 \text{ mol} \\ 34 \text{ g} \checkmark &: 1 \text{ mol} \\ x &: 5 \text{ mol} \\ x &= 170 \text{ g} \checkmark \end{aligned}$$

**OPTION 3/OPSIE 3**

$$\begin{aligned} n(O_2) &= \frac{V}{V_M} \\ &= \frac{60}{24} \checkmark \\ &= 2,5 \text{ mol} \\ n(O_2) &= \frac{m}{M} \\ \therefore 2,5 &= \frac{m}{32} \\ \therefore m &= 80 \text{ g} \\ \checkmark 2(34) \text{ g} \checkmark H_2O_2 &\dots\dots\dots 32 \text{ g } O_2 \\ x \text{ g } H_2O_2 &\dots\dots\dots 80 \text{ g } O_2 \\ m(H_2O_2) &= 170 \text{ g} \checkmark \end{aligned}$$

(4)

5.2.3 Equal to / Gelyk aan ✓

(1)

5.3

5.3.1 Q ✓

(1)

5.3.2 P ✓

(1)

**[20]**

## QUESTION 6/VRAAG 6

- 6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. ✓✓ (2 marks or no marks)

*Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie is gelyk aan die tempo van die terugwaartse reaksie.* ✓✓  
 (2 punte of geen punte nie)

### OR/OF

The state where the concentrations / quantities of reactants and products remain constant.

*Die toestand wanneer die konsentrasies / hoeveelhede van reaktanse en produkte konstant bly.* (2)

6.2

- 6.2.1 Remains the same / Bly dieselfde ✓ (1)

- 6.2.2 Decreases / Verlaag ✓



- When the temperature is increased the reaction that will oppose this increase / decrease the temperature will be favoured. ✓  
*Wanneer die temperatuur toeneem, sal die reaksie wat hierdie toename teenwerk / die temperatuur laat afneem bevoordeel word.*

### OR/OF

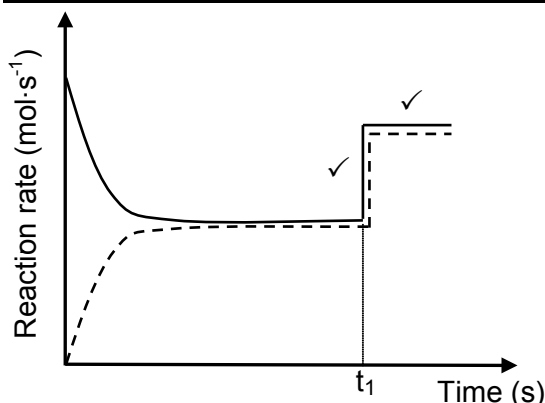
*The forward reaction is exothermic. / Die voorwaartse reaksie is eksotermies.*

- An increase in temperature favours the endothermic reaction. ✓  
*'n Toename in temperatuur bevoordeel die endotermiese reaksie.*
- The reverse reaction is favoured. ✓  
*Die terugwaartse reaksie word bevoordeel.* (4)

6.3

### Marking criteria/Nasiennriglyne:

- Vertical parallel lines show a sudden increase in rate of both forward and reverse reactions. / Vertikale parallelle lyne wys 'n skielike toename in reaksietempo van beide voorwaartse en terugwaartse reaksies. ✓
- Horizontal parallel lines showing a constant higher rate for both forward and reverse catalysed reactions after time  $t_1$ . / Horisontale parallelle lyne wat 'n konstante hoër tempo aantoon vir beide voorwaartse en terugwaartse gekataliseerde reaksies na  $t_1$ . ✓



(2)

6.4

**CALCULATIONS USING NUMBER OF MOLES**  
**BEREKENINGE WAT AANTAL MOL GEBRUIK**

**Marking criteria/Nasinriglyne:**

- Use/*Gebruik*  $M(\text{PbS}) = 239 \text{ g} \cdot \text{mol}^{-1}$  in  $n = \frac{m}{M}$  or in ratio calculation/ *of in verhoudingsberekening*. ✓
- Use ratio/*Gebruik verhouding*:  $n(\text{H}_2\text{S})_{\text{equil/ewewig}} = n(\text{PbS})$  ✓
- $n(\text{H}_2\text{S})_{\text{formed/gevorm}} = n(\text{H}_2\text{S})_{\text{equilibrium/ewewig}}$  ✓
- **USING** ratio/**GEBRUIK** *verhouding*:  $\text{H}_2 : \text{H}_2\text{S} = 1 : 1$  ✓
- $n(\text{H}_2)_{\text{equilibrium/ewewig}} = n(\text{H}_2)_{\text{initial/aanvanklik}} - n(\text{H}_2)_{\text{formed/gevorm}}$  ✓
- Divide equilibrium  $n(\text{H}_2\text{S})$  &  $n(\text{H}_2)$  by  $2 \text{ dm}^3$ . ✓  
*Deel  $n(\text{H}_2\text{S})$  &  $n(\text{H}_2)$  deur  $2 \text{ dm}^3$*
- Correct  $K_c$  expression ✓  
*Korrekte  $K_c$  uitdrukking.*
- Substitution of concentrations into  $K_c$  expression. ✓  
*Vervanging van konsentrasies in  $K_c$ -uitdrukking.*
- Final answer/*Finale antwoord*: 0,07 ✓  
**NB/L.W.:** If not rounded/*Indien nie afgerond nie*: 0,067

**OPTION 1/OPSIE 1**

$$n(\text{PbS}) = \frac{m}{M} = \frac{2,39}{239} = 0,01 \text{ mol}$$

$$n(\text{H}_2\text{S})_{\text{equilibrium/by ewewig}} = n(\text{PbS}) \checkmark = 0,01 \text{ mol}$$

	$\text{H}_2$	$\text{H}_2\text{S}$
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	0,16	0
Change (mol) <i>Verandering (mol)</i>	0,01	0,01 ✓
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,15 ✓	0,01
Equilibrium concentration ( $\text{mol} \cdot \text{dm}^{-3}$ ) <i>Ewewigskonsentrasie (<math>\text{mol} \cdot \text{dm}^{-3}</math>)</i>	0,075	0,005

ratio ✓  
*verhouding*

divide by 2 ✓  
*deel deur 2*

$$K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2]} \checkmark$$

$$= \frac{0,005}{0,075} \checkmark$$

$$= 0,067 \approx 0,07 \checkmark$$

No  $K_c$  expression, correct substitution/*Geen  $K_c$ -uitdrukking, korrekte substitusie*: Max./Maks.  $\frac{8}{9}$

Wrong  $K_c$  expression /*Verkeerde  $K_c$ -uitdrukking*:  
 Max./Maks.  $\frac{6}{9}$

**IF/INDIEN:**  $[\text{S}] = 1$  in  $K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2][\text{S}]}$

No mark for  $K_c$  expression, but continue marking substitution and answer./*Geen punt vir  $K_c$ -uitdrukking, maar gaan voort om substitusie en antwoord na te sien.*



**OPTION 2/OPSIE 2**

$$\begin{aligned} n(\text{PbS}) &= \frac{m}{M} \\ &= \frac{2,39}{239} \checkmark \\ &= 0,01 \text{ mol} \end{aligned}$$

$$\begin{aligned} n(\text{H}_2\text{S})_{\text{reacted/gerageer}} &= n(\text{PbS}) \checkmark = 0,01 \text{ mol} \\ &= n(\text{H}_2\text{S})_{\text{equilibrium/ewewig}} \end{aligned}$$

$$\begin{aligned} n(\text{H}_2\text{S})_{\text{formed/gevorm}} &= n(\text{H}_2\text{S})_{\text{equilibrium/ewewig}} - n(\text{H}_2\text{S})_{\text{initial/aanvanklik}} \\ &= 0,01 - 0 \checkmark \\ &= 0,01 \text{ mol} \end{aligned}$$

$$n(\text{H}_2)_{\text{reacted/gerageer}} = n(\text{H}_2\text{S})_{\text{formed/gevorm}} \checkmark = 0,01 \text{ mol}$$

$$\begin{aligned} n(\text{H}_2)_{\text{equilibrium/ewewig}} &= n(\text{H}_2)_{\text{initial/aanvanklik}} - n(\text{H}_2)_{\text{reacted/gerageer}} \\ &= 0,16 - 0,01 \checkmark \\ &= 0,15 \text{ mol} \end{aligned}$$

$$\begin{aligned} c(\text{H}_2) &= \frac{n}{V} \\ &= \frac{0,15}{2} \\ &= 0,075 \text{ mol} \cdot \text{dm}^{-3} \end{aligned}$$

$$\begin{aligned} c(\text{H}_2\text{S}) &= \frac{n}{V} \\ &= \frac{0,01}{2} \checkmark \\ &= 0,005 \text{ mol} \cdot \text{dm}^{-3} \end{aligned}$$

$$\begin{aligned} K_c &= \frac{[\text{H}_2\text{S}]}{[\text{H}_2]} \checkmark \\ &= \frac{0,005}{0,075} \checkmark \\ &= 0,067 \approx 0,07 \checkmark \end{aligned}$$

No  $K_c$  expression, correct substitution/Geen  $K_c$ -uitdrukking, korrekte substitusie: Max./Maks.  $\frac{8}{9}$

Wrong  $K_c$  expression /Verkeerde  $K_c$ -uitdrukking:  
Max./Maks.  $\frac{6}{9}$

**IF/INDIEN:**  $[\text{S}] = 1$  in  $K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2][\text{S}]}$

No mark for  $K_c$  expression, but continue marking substitution and answer./Geen punt vir  $K_c$ -uitdrukking, maar gaan voort om substitusie en antwoord na te sien.

**OPTION 3/OPSIE 3**

	H <sub>2</sub>	H <sub>2</sub> S	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	0,16	0	
Change (mol) <i>Verandering (mol)</i>	x	x ✓	ratio ✓ verhouding
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,16 - x ✓	x	
Equilibrium concentration (mol·dm <sup>-3</sup> ) <i>Ewewigskonsentrasie (mol·dm<sup>-3</sup>)</i>	$\frac{0,16 - x}{2}$	$\frac{x}{2}$	divide by 2 ✓ deel deur 2

$$n(\text{PbS}) = \frac{m}{M}$$

$$= \frac{2,39}{239} \checkmark$$

$$= 0,01 \text{ mol}$$

$$n(\text{H}_2\text{S})_{\text{equilibrium/by ewewig}} = n(\text{PbS}) \checkmark \therefore x = 0,01 \text{ mol}$$

$$[\text{H}_2]_{\text{equilibrium/by ewewig}} = \frac{0,16 - 0,01}{2} = 0,075 \text{ mol} \cdot \text{dm}^{-3}$$

$$[\text{H}_2\text{S}]_{\text{equilibrium/by ewewig}} = \frac{0,01}{2} = 0,005 \text{ mol} \cdot \text{dm}^{-3}$$

$$K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2]} \checkmark$$

$$= \frac{0,005}{0,075} \checkmark$$

$$= 0,067 \approx 0,07 \checkmark$$

No K<sub>c</sub> expression, correct substitution/Geen K<sub>c</sub>-  
 uitdrukking, korrekte substitusie: Max./Maks.  $\frac{8}{9}$

Wrong K<sub>c</sub> expression /Verkeerde K<sub>c</sub>-uitdrukking:  
 Max./Maks.  $\frac{6}{9}$

**IF/INDIEN:**  $[\text{S}] = 1$  in  $K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2][\text{S}]}$

No mark for K<sub>c</sub> expression, but continue marking substitution and answer./Geen  
 punt vir K<sub>c</sub>-uitdrukking, maar gaan voort om substitusie en antwoord na te sien.

**CALCULATIONS USING CONCENTRATION**  
**BEREKENINGE WAT KONSENTRASIE GEBRUIK**

**Marking criteria/Nasinriglyne:**

- Use/Gebruik  $M(\text{PbS}) = 239 \text{ g} \cdot \text{mol}^{-1}$  in  $n = \frac{m}{M}$  or in ratio calculation/ of in verhoudingsberekening. ✓
- Use ratio/Gebruik verhouding:  $n(\text{H}_2\text{S})_{\text{equil/ewewig}} = n(\text{PbS})$  ✓
- Divide equilibrium  $n(\text{H}_2\text{S})_{\text{equil}}$  &  $n(\text{H}_2)_{\text{initial}}$  by  $2 \text{ dm}^3$ . ✓  
 Deel  $n(\text{H}_2\text{S})_{\text{ewewig}}$  &  $n(\text{H}_2)_{\text{aanvanklik}}$  deur  $2 \text{ dm}^3$
- $[\text{H}_2\text{S}]_{\text{formed/gevorm}} = [\text{H}_2\text{S}]_{\text{equilibrium/ewewig}}$  ✓
- **USING** ratio/**GEBRUIK** verhouding:  $\text{H}_2 : \text{H}_2\text{S} = 1 : 1$  ✓
- $[\text{H}_2]_{\text{equilibrium/ewewig}} = [\text{H}_2]_{\text{initial/aanvanklik}} - [\text{H}_2]_{\text{formed/gevorm}}$  ✓
- Correct  $K_c$  expression ✓  
 Korrekte  $K_c$  uitdrukking.
- Substitution of concentrations into  $K_c$  expression. ✓  
 Vervanging van konsentrasies in  $K_c$ -uitdrukking.
- Final answer/Finale antwoord: 0,07 ✓  
**Note/Let Wel:** If not rounded/Indien nie afgerond nie: 0,067

**OPTION 4/OPSIE 4**

$$n(\text{PbS}) = \frac{m}{M} = \frac{2,39}{239} = 0,01 \text{ mol}$$

$$n(\text{H}_2\text{S})_{\text{equilibrium/by ewewig}} = n(\text{PbS}) \checkmark = 0,01 \text{ mol}$$

	$\text{H}_2$	$\text{H}_2\text{S}$
Initial concentration/Aanvangskonsentrasie ( $\text{mol} \cdot \text{dm}^{-3}$ )	$\frac{0,16}{2} = 0,08$	0
Change in concentration/Verandering in konsentrasie ( $\text{mol} \cdot \text{dm}^{-3}$ )	0,005	0,005 ✓
Equilibrium concentration/Ewewigskonsentrasie ( $\text{mol} \cdot \text{dm}^{-3}$ )	0,075	$\frac{0,01}{2} = 0,005$

$$K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2]}$$

$$= \frac{0,005}{0,075}$$

$$= 0,067 \approx 0,07$$

No  $K_c$  expression, correct substitution/Geen  $K_c$ -uitdrukking, korrekte substitusie: Max./Maks.  $\frac{8}{9}$

Wrong  $K_c$  expression /Verkeerde  $K_c$ -uitdrukking:  
 Max./Maks.  $\frac{6}{9}$

**IF/INDIEN:**  $[\text{S}] = 1$  in  $K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2][\text{S}]}$

No mark for  $K_c$  expression, but continue marking substitution and answer./Geen punt vir  $K_c$ -uitdrukking, maar gaan voort om substitusie en antwoord na te sien.

**OPTION 5/OPSIE 5**

$$\begin{aligned} n(\text{PbS}) &= \frac{m}{M} \\ &= \frac{2,39}{239} \\ &= 0,01 \text{ mol} \end{aligned}$$

$$n(\text{H}_2\text{S})_{\text{equilibrium/by ewewig}} = n(\text{PbS}) \checkmark = 0,01 \text{ mol}$$

$$\begin{aligned} [\text{H}_2\text{S}]_{\text{equilibrium/by ewewig}} &= \frac{n}{V} \\ &= \frac{0,01}{2} \\ &= 0,005 \text{ mol} \cdot \text{dm}^{-3} \end{aligned}$$

$$\begin{aligned} [\text{H}_2]_{\text{initial/aanvanklik}} &= \frac{n}{V} \\ &= \frac{0,16}{2} \\ &= 0,08 \text{ mol} \cdot \text{dm}^{-3} \end{aligned}$$

$$\begin{aligned} [\text{H}_2\text{S}]_{\text{formed/gevorm}} &= [\text{H}_2\text{S}]_{\text{equilibrium/by ewewig}} - [\text{H}_2\text{S}]_{\text{initial/aanvanklik}} \\ &= 0,005 - 0 \checkmark \\ &= 0,005 \text{ mol} \cdot \text{dm}^{-3} \end{aligned}$$

$$[\text{H}_2]_{\text{reacted/gereageer}} = [\text{H}_2\text{S}]_{\text{formed/gevorm}} \checkmark = 0,005 \text{ mol}$$

$$\begin{aligned} [\text{H}_2]_{\text{equilibrium/ewewig}} &= [\text{H}_2]_{\text{initial/aanvanklik}} - [\text{H}_2]_{\text{reacted/gereageer}} \\ &= 0,08 - 0,005 \checkmark \\ &= 0,075 \text{ mol} \end{aligned}$$

$$\begin{aligned} K_c &= \frac{[\text{H}_2\text{S}]}{[\text{H}_2]} \\ &= \frac{0,005}{0,075} \\ &= 0,067 \approx 0,07 \end{aligned}$$

No  $K_c$  expression, correct substitution/Geen  $K_c$ -uitdrukking, korrekte substitusie: Max./Maks.  $\frac{8}{9}$

Wrong  $K_c$  expression /Verkeerde  $K_c$ -uitdrukking: Max./Maks.  $\frac{6}{9}$

**IF/INDIEN:**  $[\text{S}] = 1$  in  $K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2][\text{S}]}$

No mark for  $K_c$  expression, but continue marking substitution and answer./Geen punt vir  $K_c$ -uitdrukking, maar gaan voort om substitusie en antwoord na te sien.

(9)  
[18]

## QUESTION 7/VRAAG 7

7.1

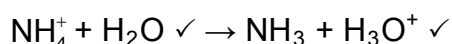
- 7.1.1 Hydrolysis is the reaction (of a salt) with water. ✓✓  
*Hidrolise is die reaksie (van 'n sout) met water.*  
**(2 or/of 0)**

**Accept/Aanvaar:**

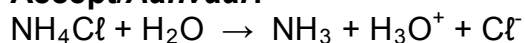
A chemical reaction in which water is a reactant.  
*'n Chemiese reaksie waarin water 'n reaktans is.*

(2)

- 7.1.2 Smaller than (7)/Kleiner as (7) ✓



**Accept/Aanvaar:**



**Note/Aantekening:**

- Mark equation independently of first answer./Sien vergelyking onafhanklik van eerste antwoord na.
- If incorrect balancing/Indien verkeerde balansering: Max/Maks.  $\frac{2}{3}$

**Marking criteria for equation/Nasienriglyne vir vergelyking:**

- Reactants ✓ Products ✓  
*Reaktanse Produkte*
- Ignore double arrows and phases./Ignoreer dubbelpyle en fases.
- Marking rule 6.3.10/Nasienreël 6.3.10.

(3)

7.2

7.2.1

**Marking guidelines/Nasienriglyne:**

- Substitution of/Substitusie van  $98 \text{ g} \cdot \text{mol}^{-1}$ . ✓
- Final answer/Finale antwoord:  $0,08 \text{ mol}$  ✓

**Note/Let wel:**

If not rounded/Indien nie afgerond nie:  $(0,075 \text{ mol})$

**OPTION 1/OPSIE 1**

$$\begin{aligned} n &= \frac{m}{M} \\ &= \frac{7,35}{98} \\ &= 0,08 \text{ mol } \checkmark \quad (0,075 \text{ mol}) \end{aligned}$$

**OPTION 2/OPSIE 2**

$$\begin{aligned} 98 \text{ g } \checkmark &: 1 \text{ mol} \\ 7,35 &: 0,08 \text{ mol } \checkmark \end{aligned}$$

**OPTION 3/OPSIE 3**

$$\begin{aligned} c &= \frac{m}{MV} \\ &= \frac{7,35}{98 \times 0,5} \\ &= 0,15 \text{ mol} \cdot \text{dm}^{-3} \end{aligned}$$

$$\begin{aligned} n &= cV \\ &= 0,15 \times 0,5 \\ &= 0,08 \text{ mol } \checkmark \end{aligned}$$

(2)

7.2.2 **POSITIVE MARKING FROM QUESTION 7.2.1.**  
**POSITIEWE NASIEN VAN VRAAG 7.2.1.**

Q7.2.1	<p><b>OPTION 1/OPSIE 1</b></p> <p><math>\text{pH} = -\log[\text{H}_3\text{O}^+] \checkmark</math>  <math>1,3 \checkmark = -\log[\text{H}_3\text{O}^+]</math>  <math>[\text{H}_3\text{O}^+] = 0,05 \text{ mol}\cdot\text{dm}^{-3}</math></p> <p><math>[\text{H}_2\text{SO}_4] = \frac{1}{2}[\text{H}_3\text{O}^+] \checkmark</math>  <math>= \frac{1}{2} \times 0,05 \checkmark</math>  <math>= 0,025 \text{ mol}\cdot\text{dm}^{-3} \quad (0,03)</math></p> <p><math>n(\text{H}_2\text{SO}_4)_{\text{ex/or}} = cV \checkmark</math>  <math>= 0,025 \times 0,5 \checkmark</math>  <math>= 0,0125 \text{ mol} \quad (0,02)</math></p> <p><math>n(\text{H}_2\text{SO}_4)_{\text{react/rea}} = 0,075 - 0,0125 \checkmark</math>  <math>= 0,0625 \text{ mol} \quad (0,06)</math></p> <p><math>n(\text{NaOH}) = 2n(\text{H}_2\text{SO}_4) \checkmark</math>  <math>= 2 \times 0,0625 \checkmark</math>  <math>= 0,125 \text{ mol} \quad (0,12)</math></p>	<p><b>Marking guidelines/Nasienriglyne:</b></p> <ul style="list-style-type: none"> <li>Formula/Formule: <math>\text{pH} = -\log[\text{H}_3\text{O}^+] \checkmark</math></li> <li>Substitution of/Substitusie van 1,3 <math>\checkmark</math></li> <li>Use <math>[\text{H}_2\text{SO}_4] : [\text{H}_3\text{O}^+] = 1 : 2 \checkmark</math>                      Gebruik <math>[\text{H}_2\text{SO}_4] : [\text{H}_3\text{O}^+] = 1 : 2</math></li> <li>Formula/Formule: <math>c = \frac{n}{V} \checkmark</math></li> <li>Multiply by <math>0,5 \text{ dm}^3</math>                      Vermenigvuldig met <math>0,5 \text{ dm}^3 \checkmark</math></li> <li>Subtract <math>n_{\text{initial}} - n_{\text{excess}} \checkmark</math>                      Af trek: <math>n_{\text{begin}} - n_{\text{oormaat}}</math></li> <li>Use <math>n(\text{NaOH}) : n(\text{H}_2\text{SO}_4) = 2:1 \checkmark</math>                      Gebruik <math>n(\text{NaOH}) : n(\text{H}_2\text{SO}_4) = 2:1</math></li> <li>Substitution of <math>40 \text{ g}\cdot\text{mol}^{-1} \checkmark</math>                      Vervanging van <math>40 \text{ g}\cdot\text{mol}^{-1}</math></li> <li>Final answer: <math>m = 5 \text{ g} \checkmark</math>                      Finale antwoord: <math>m = 5 \text{ g}</math></li> </ul> <p>Range/Gebied: 4,8 – 5,6 g</p>
	<p><b>OR/OF</b></p> <p><math>n(\text{NaOH}) = \frac{m}{M}</math>  <math>0,125 = \frac{m}{40} \checkmark</math>  <math>m = 5 \text{ g} \checkmark \quad (4,8 \text{ g})</math></p>	<p>1 mol : 40 g <math>\checkmark</math>                      0,125 mol : 5 g <math>\checkmark</math></p>

OPTION 2/OPSIE 2	Marking guidelines/Nasienriglyne:
<p> <math>\text{pH} = -\log[\text{H}_3\text{O}^+] \checkmark</math>  <math>1,3 \checkmark = -\log[\text{H}_3\text{O}^+]</math>  <math>[\text{H}_3\text{O}^+] = 0,05 \text{ mol} \cdot \text{dm}^{-3}</math>  <math>n(\text{H}_3\text{O}^+)_{\text{ex/oor}} = cV \checkmark</math>  <math>= (0,05)(0,5) \checkmark</math>  <math>= 0,025 \text{ mol} \quad (0,03)</math>  <math>n(\text{H}_3\text{O}^+)_{\text{in/aanv}} = 2n(\text{H}_2\text{SO}_4) \checkmark</math>  <math>= 0,075 \times 2 \checkmark</math>  <math>= 0,15 \text{ mol} \quad (0,16)</math>  <math>n(\text{H}_3\text{O}^+)_{\text{react/reageer}} = 0,15 - 0,025 \checkmark</math>  <math>= 0,125 \text{ mol} \quad (0,13)</math>  <math>n(\text{NaOH}) = n(\text{H}_3\text{O}^+) \checkmark</math>  <math>= 0,125 \text{ mol} \quad (0,13)</math> </p>	<p> <b>Marking guidelines/Nasienriglyne:</b>  <ul style="list-style-type: none"> <li>Formula/Formule: <math>\text{pH} = -\log[\text{H}_3\text{O}^+] \checkmark</math></li> <li>Substitution of/Substitusie van 1,3 <math>\checkmark</math></li> <li>Formula/Formule: <math>c = \frac{n}{V} \checkmark</math></li> <li>Multiply by <math>0,5 \text{ dm}^3</math>  <i>Vermenigvuldig met <math>0,5 \text{ dm}^3</math> <math>\checkmark</math></i></li> <li>Use <math>n(\text{H}_2\text{SO}_4) : n(\text{H}_3\text{O}^+) = 1 : 2 \checkmark</math>  <i>Gebruik <math>n(\text{H}_2\text{SO}_4) : n(\text{H}_3\text{O}^+) = 1 : 2</math></i></li> <li>Subtract <math>n_{\text{initial}} - n_{\text{excess}} \checkmark</math>  <i>Aftrek: <math>n_{\text{begin}} - n_{\text{oormaat}}</math></i></li> <li>Use <math>n(\text{H}_3\text{O}^+) : n(\text{NaOH}) = 1 : 1 \checkmark</math>  <i>Gebruik <math>n(\text{H}_3\text{O}^+) : n(\text{NaOH}) = 1 : 1</math></i></li> <li>Substitution of <math>40 \text{ g} \cdot \text{mol}^{-1} \checkmark</math>  <i>Vervanging van <math>40 \text{ g} \cdot \text{mol}^{-1}</math></i></li> <li>Final answer: <math>m = 5 \text{ g} \checkmark</math>  <i>Finale antwoord: <math>m = 5 \text{ g}</math></i></li> </ul> </p> <p>Range/Gebied: 4,8 – 5,6 g</p>
<p> <b>OR/OF</b>  <math>n(\text{NaOH}) = \frac{m}{M}</math>  <math>0,125 = \frac{m}{40} \checkmark</math>  <math>m = 5 \text{ g} \checkmark \quad (5,2 \text{ g})</math> </p>	<p> <math>1 \text{ mol} : 40 \text{ g} \checkmark</math>  <math>0,125 \text{ mol} : 5 \text{ g} \checkmark</math> </p>

**OPTION 3/OPSIE 3**

Q7.2.1

$$[\text{H}_2\text{SO}_4]_{\text{in/aanv}} = \frac{n}{V} \checkmark$$

$$= \frac{0,075}{0,5} \checkmark$$

$$= 0,15 \text{ mol} \cdot \text{dm}^{-3} \quad (0,16)$$

$$[\text{H}_3\text{O}^+]_{\text{in/aanv}} = 2[\text{H}_2\text{SO}_4]$$

$$= 2 \times 0,15 \checkmark$$

$$= 0,3 \text{ mol} \cdot \text{dm}^{-3} \quad (0,32)$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+] \checkmark$$

$$1,3 \checkmark = -\log[\text{H}_3\text{O}^+]$$

$$[\text{H}_3\text{O}^+] = 0,05 \text{ mol} \cdot \text{dm}^{-3}$$

$$[\text{H}_3\text{O}^+]_{\text{react/rea}} = 0,3 - 0,05 \checkmark$$

$$= 0,25 \text{ mol} \cdot \text{dm}^{-3} \quad (0,27)$$

$$[\text{H}_2\text{SO}_4]_{\text{react/rea}} = \frac{1}{2}[\text{H}_3\text{O}^+]$$

$$= \frac{1}{2} \times 0,25$$

$$= 0,125 \text{ mol} \cdot \text{dm}^{-3} \quad (0,14)$$

**Marking guidelines/Nasienriglyne:**

- Formula/Formule:  $c = \frac{n}{V} \checkmark$
- Divide by  $0,5 \text{ dm}^3$   
Deel deur  $0,5 \text{ dm}^3 \checkmark$
- Use  $[\text{H}_3\text{O}^+] : [\text{H}_2\text{SO}_4] = 2:1 \checkmark$   
Gebruik  $[\text{H}_3\text{O}^+] : [\text{H}_2\text{SO}_4] = 2:1$
- Formula/Formule:  $\text{pH} = -\log[\text{H}_3\text{O}^+] \checkmark$
- Substitution of/Substitusie van  $1,3 \checkmark$
- Subtract  $[\text{H}_3\text{O}^+]_{\text{initial}} - [\text{H}_3\text{O}^+]_{\text{excess}} \checkmark$   
Aftrek:  $[\text{H}_3\text{O}^+]_{\text{begin}} - [\text{H}_3\text{O}^+]_{\text{oormaat}}$
- Use  $n(\text{NaOH}) : n(\text{H}_2\text{SO}_4) = 2:1 \checkmark$   
Gebruik  $n(\text{NaOH}) : n(\text{H}_2\text{SO}_4) = 2:1$
- OR/OF**
- Use  $[\text{H}_2\text{SO}_4] : [\text{NaOH}] = 1 : 2 \checkmark$   
Gebruik  $[\text{H}_2\text{SO}_4] : [\text{NaOH}] = 1 : 2$
- Substitution of  $40 \text{ g} \cdot \text{mol}^{-1} \checkmark$   
Vervanging van  $40 \text{ g} \cdot \text{mol}^{-1}$
- Final answer:  $m = 5 \text{ g} \checkmark$   
Finale antwoord:  $m = 5 \text{ g}$

Range/Gebied:  $4,8 - 5,6 \text{ g}$

**OR/OF**

$$n(\text{H}_2\text{SO}_4)_{\text{react/reageer}} = cV$$

$$= (0,125)(0,5)$$

$$= 0,0625 \text{ mol} \quad (0,07)$$

$$n(\text{NaOH}) = 2n(\text{H}_2\text{SO}_4)$$

$$= 2 \times 0,0625 \checkmark$$

$$= 0,125 \text{ mol} \quad (0,14)$$

$$n(\text{NaOH}) = \frac{m}{M}$$

$$0,125 = \frac{m}{40} \checkmark$$

$$m = 5 \text{ g} \checkmark \quad (5,6 \text{ g})$$

$$[\text{H}_2\text{SO}_4] : [\text{NaOH}]$$

$$1 : 2$$

$$0,125 : 0,25 \checkmark \quad (0,28)$$

$$m = cMV$$

$$= 0,25 \times 40 \checkmark \times 0,5$$

$$= 5 \text{ g} \checkmark \quad (5,6 \text{ g})$$

(9)  
[16]



### QUESTION 8/VRAAG 8

8.1

8.1.1  $\text{AgNO}_3$  / Silver nitrate ✓  
 $\text{AgNO}_3$  / Silwernittraat

(1)

8.1.2  $\text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^-$  ✓✓

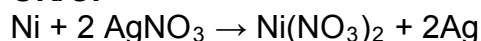
**Marking guidelines/Nasienriglyne:**

- $\text{Ni} \rightleftharpoons \text{Ni}^{2+} + 2\text{e}^-$   $\frac{1}{2}$   $\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}$   $\frac{0}{2}$   
 $\text{Ni}^{2+} + 2\text{e}^- \leftarrow \text{Ni}$   $\frac{2}{2}$   $\text{Ni}^{2+} + 2\text{e}^- \rightarrow \text{Ni}$   $\frac{0}{2}$
  - Ignore if charge omitted on electron. / Ignoreer indien lading weggelaat op elektron.
  - If charge (+) omitted on  $\text{Ni}^{2+}$  / Indien lading (+) weggelaat op  $\text{Ni}^{2+}$ : Max./Maks:  $\frac{1}{2}$
- Example/Voorbeeld:  $\text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^-$  ✓

(2)

8.1.3  $\text{Ni} + 2\text{Ag}^+ \checkmark \rightarrow \text{Ni}^{2+} + 2\text{Ag} \checkmark$  Bal ✓

**OR/OF**




**Notes/Aantekeninge:**

- Reactants ✓ Products ✓ Balancing: ✓  
 Reaktanse Produkte Balansering
- Ignore double arrows. / Ignoreer dubbelpyle.
- Marking rule 6.3.10 / Nasienreël 6.3.10.

(3)

8.2

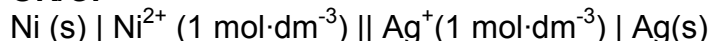
8.2.1  Ni ✓

Ni is a stronger reducing agent. / Ni has a higher reducing ability. / Ni is the anode. / Ni loses electrons. / Ni is oxidised. ✓  
*Ni is die sterker reduseermiddel. / Ni het sterker reduseer vermoë. / Ni is die anode. / Ni verloor elektrone. / Ni word geoksideer.*

(2)

8.2.2  $\text{Ni}(\text{s}) \checkmark \mid \text{Ni}^{2+}(\text{aq}) \parallel \text{Ag}^+(\text{aq}) \checkmark \mid \text{Ag}(\text{s}) \checkmark$

**OR/OF**



**Accept/Aanvaar:**



(3)

8.2.3

<p><b>OPTION 1/OPSIE 1</b></p> $E_{\text{cell}}^{\theta} = E_{\text{reduction}}^{\theta} - E_{\text{oxidation}}^{\theta} \checkmark$ $= 0,80 \checkmark - (-0,27) \checkmark$ $= 1,07 \text{ V} \checkmark$	<p><b>Notes/Aantekeninge</b></p> <ul style="list-style-type: none"> <li>Accept any other correct formula from the data sheet./<i>Aanvaar enige ander korrekte formule vanaf gegewensblad.</i></li> <li>Any other formula using unconventional abbreviations, e.g. <math>E_{\text{cell}}^{\theta} = E_{\text{OA}}^{\theta} - E_{\text{RA}}^{\theta}</math> followed by correct substitutions./<i>Enige ander formule wat onkonvensionele afkortings gebruik bv. <math>E_{\text{sel}}^{\theta} = E_{\text{OM}}^{\theta} - E_{\text{RM}}^{\theta}</math> gevolg deur korrekte vervangings.</i> <math>\frac{3}{4}</math></li> </ul>
<p><b>OPTION 2/OPSIE 2</b></p> $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag} \quad \checkmark$ $\text{Ni} \rightarrow \text{Ni}^{2+} + 2\text{e}^- \quad \checkmark$ $\text{Ag}^+ + \text{Ni} \rightarrow \text{Ag} + \text{Ni}^{2+} \quad \checkmark$	$E^{\theta} = 0,80 \text{ V} \checkmark$ $E^{\theta} = +0,27 \text{ V} \checkmark$ $E^{\theta} = +1,07 \text{ V} \checkmark$

(4)

8.2.4 Increases / Verhoog  $\checkmark$

(1)

[16]

### QUESTION 9/VRAAG 9

9.1 Endothermic / Endotermies  $\checkmark$

(1)

9.2 Anode  $\checkmark$



Connected to the positive terminal of the battery.  $\checkmark$   
 Geskakel aan positiewe terminaal van battery.

(2)

9.3

9.3.1 Chlorine (gas) /  $\text{Cl}_2$  / Chloor(gas)  $\checkmark$

(1)

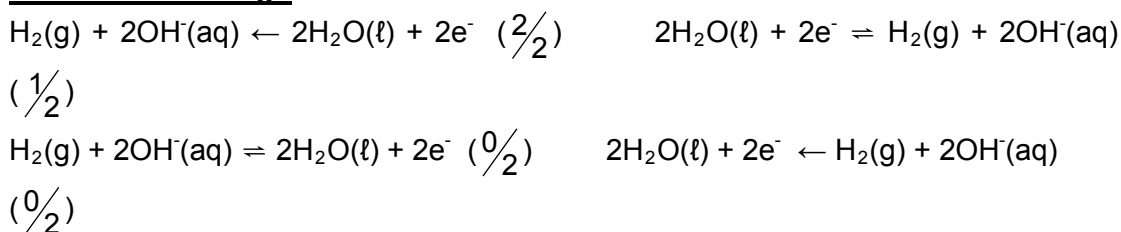
9.3.2 Hydrogen (gas) /  $\text{H}_2$  / Waterstof(gas)  $\checkmark$

(1)

9.3.3  $2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq}) \checkmark \checkmark$

Ignore phases/Ignoreer fases

**Notes/Aantekeninge**



(2)

9.4 Basic / Basies  $\checkmark$



**OR/OF** Alkaline / Alkalies

$\text{OH}^-$  (ions) / NaOH / Strong base forms.  $\checkmark$   
 $\text{OH}^-$  (-ione) / NaOH / Sterk basis vorm.

(2)



**QUESTION 10/VRAAG 10**

10.1

10.1.1 Haber (process) / *Haberproses* ✓ (1)

10.1.2 Contact process / Catalytic oxidation of  $\text{SO}_2$  ✓  
*Kontakproses / Katalitiese oksidasie van  $\text{SO}_2$*  (1)

10.1.3 Sulphur trioxide /  $\text{SO}_3$  / *Swaweltrioksied* ✓ (1)

10.1.4  $\text{SO}_3 + \text{H}_2\text{SO}_4 \checkmark \rightarrow \text{H}_2\text{S}_2\text{O}_7 \checkmark$  Bal. ✓

**Notes/Aantekeninge**

- Reactants ✓ Products ✓ Balancing ✓  
*Reaktanse Produkte Balansering*
- Ignore/*Ignoreer*  $\rightleftharpoons$  and phases/*en fases*.
- Marking rule 6.3.10/*Nasienreël 6.3.10*

(3)

10.1.5  $\text{H}_2\text{SO}_4 \checkmark + 2\text{NH}_3 \checkmark \rightarrow (\text{NH}_4)_2\text{SO}_4 \checkmark$  Bal. ✓

**Notes/Aantekeninge**

- Reactants ✓✓ Products ✓ Balancing ✓  
*Reaktanse Produkte Balansering*
- Ignore/*Ignoreer*  $\rightleftharpoons$  and phases/*en fases*.
- Marking rule 6.3.10/*Nasienreël 6.3.10*

(4)

10.2

**Marking guidelines/Nasienriglyne:**

- Calculate the mass of fertiliser./Bereken die massa kunsmis.
- Add %N and %P OR/OF mass N and mass P.  
 Tel %N en %P OR/OF massa N en massa P bymekaar.
- Subtraction/Aftrekking:  $100 - (\%N + \%P)$   
 OR/OF  $m(\text{fertiliser/kunsmis}) - [m(N) + m(P)]$   
 OR/OF  $\% \text{fertiliser/kunsmis} - [\%N + \%P]$
- Final answer/Finale antwoord: 8:1:5

**OPTION 1/OPSIE 1**

$$m(\text{fertiliser/kunsmis}) = \frac{36}{100} \times 20 \checkmark$$

$$= 7,2 \text{ kg}$$

$$\%N = \frac{4,11}{7,2} \times 100$$

$$= 57,08\%$$

$$\%P = \frac{0,51}{7,2} \times 100$$

$$= 7,08\%$$

$$\%K = \frac{100 - \checkmark}{\checkmark} (57,08 + 7,08) \checkmark$$

$$= 35,84\%$$

$$57,08 : 7,08 : 35,84$$

$$8 : 1 : 5 \checkmark$$

**OPTION 2/OPSIE 2**

$$m(\text{fertiliser/kunsmis}) = \frac{36}{100} \times 20 \checkmark$$

$$= 7,2 \text{ kg}$$

$$m(K) = \frac{7,2 - \checkmark}{\checkmark} (4,11 + 0,51) \checkmark$$

$$= 2,58 \text{ kg}$$

$$4,11 : 0,51 : 2,58$$

$$8 : 1 : 5 \checkmark$$

**OPTION 3/OPSIE 3**

$$\%N = \frac{4,11}{20} \times 100 = 20,55\%$$

$$\%P = \frac{0,51}{20} \times 100 = 2,55\%$$

$$\%K = \frac{36 - \checkmark}{\checkmark} (20,55 + 2,55) \checkmark = 12,9\%$$

$$20,55 : 2,55 : 12,9$$

$$8 : 1 : 5 \checkmark$$

(4)  
**[14]**

**TOTAL/TOTAAL: 150**