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# NATIONAL SENIOR CERTIFICATE

## GRADE 12

### SEPTEMBER 2024

## PHYSICAL SCIENCES P2 (CHEMISTRY)

**MARKS:** 150

**TIME:** 3 hours

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This question paper consists of 19 pages, including 4 data sheets.

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**INSTRUCTIONS AND INFORMATION**

1. Write your full NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of NINE 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. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, et cetera where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 Which ONE of the following homologous series contains a hydroxyl group that is bonded to a saturated carbon atom?

A Ketones

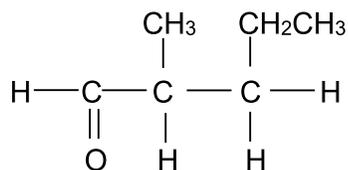
B Aldehydes

C Alcohols

D Esters

(2)

1.2 Consider the compound shown below:



The CORRECT IUPAC name of the above compound is:

A 3-ethyl-2-methylpropanal

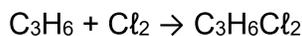
B 2-methyl-3-ethylpropanal

C 2-methylpentanal

D 4-methylpentanal

(2)

1.3 Consider the reaction:



The name of the reaction is ...

A hydration

B halogenation

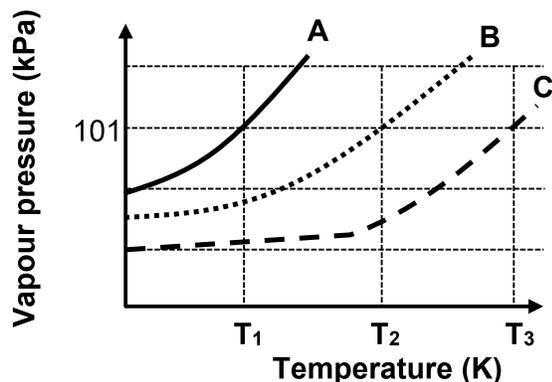
C hydrogenation

D hydrolysis

(2)

- 1.4 Consider the vapour pressure against temperature curves for THREE CHAIN ISOMERS under standard atmospheric pressure.

**VAPOUR PRESSURE VERSUS TEMPERATURE**

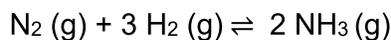


Consider the statements regarding the curves for the THREE CHAIN ISOMERS.

- I Compound **A** has the shortest chain length.
- II The boiling point of compound **B** is  $T_2$ .
- III Compound **C** is at a gaseous phase at  $T_2$ .

Which of the above statement(s) is/are true?

- A I and II only
  - B III only
  - C II and III only
  - D I and III only
- (2)
- 1.5 Consider the synthesis reaction of ammonia,  $\text{NH}_3$ :

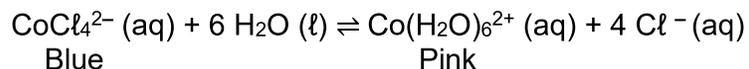


The rate at which  $\text{N}_2(\text{g})$  is consumed during the reaction is  $x \text{ mol}\cdot\text{dm}^{-3}\cdot\text{s}^{-1}$ .

Which ONE of the following is the rate at which ammonia,  $\text{NH}_3(\text{g})$  is produced in  $\text{mol}\cdot\text{dm}^{-3}\cdot\text{s}^{-1}$  with respect to  $\text{N}_2(\text{g})$ ?

- A  $x$
  - B  $2x$
  - C  $\frac{x}{2}$
  - D  $3x$
- (2)

1.6 Consider the following reaction at equilibrium:



The solution is currently **pink**.

Concentrated hydrochloric acid (HCl) is added to the equilibrium mixture.

Which ONE of the following combinations CORRECTLY describes the effect that the addition of concentrated hydrochloric acid (HCl) will have on the equilibrium constant,  $K_c$  and the colour change of the solution?

	<b><math>K_c</math></b>	<b>COLOUR CHANGE</b>
A	No Effect	Solutions turns pinker
B	No Effect	Solution turns blue
C	Increases	Solution turns blue
D	Decreases	Solution turns pinker

(2)

1.7 Which ONE of the following substances can be classified as a Lowry-Brønsted acid?



(2)

1.8 Consider the salt,  $\text{CH}_3\text{COONa}$ .

Which ONE of the following combinations CORRECTLY identifies the hydrolysis reaction and the pH of the salt?

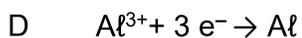
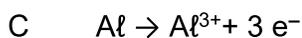
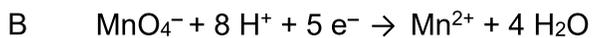
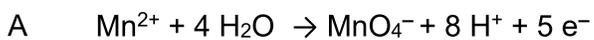
	<b>HYDROLYSIS</b>	<b>pH</b>
A	$\text{CH}_3\text{COO}^- + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COOH} + \text{OH}^-$	Greater than 7
B	$\text{CH}_3\text{COO}^- + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COOH} + \text{OH}^-$	Less than 7
C	$\text{Na}^+ + \text{H}_2\text{O} \rightleftharpoons \text{NaOH} + \text{H}_2\text{O}$	Greater than 7
D	$\text{CH}_3\text{COO}^- + \text{Na}^+ \rightleftharpoons \text{CH}_3\text{COONa}$	Equal to 7

(2)

1.9 Consider the cell notation of a galvanic cell below:

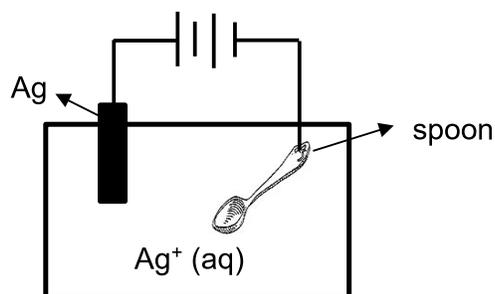


Which ONE of the following reactions occurs at the cathode?

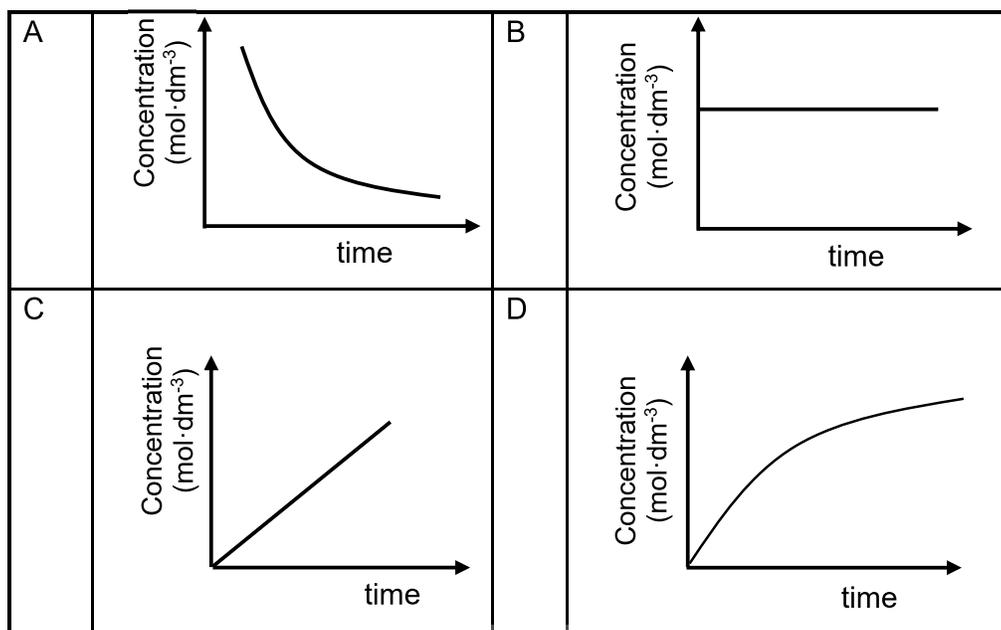


(2)

1.10 A spoon is plated with silver (Ag) during the process of electrolysis.



Which ONE of the following graphs BEST represents the concentration of the silver ions ( $\text{Ag}^+$ ) in the electrolyte over time?

(2)  
[20]

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

Consider the organic compounds **A–E** below.

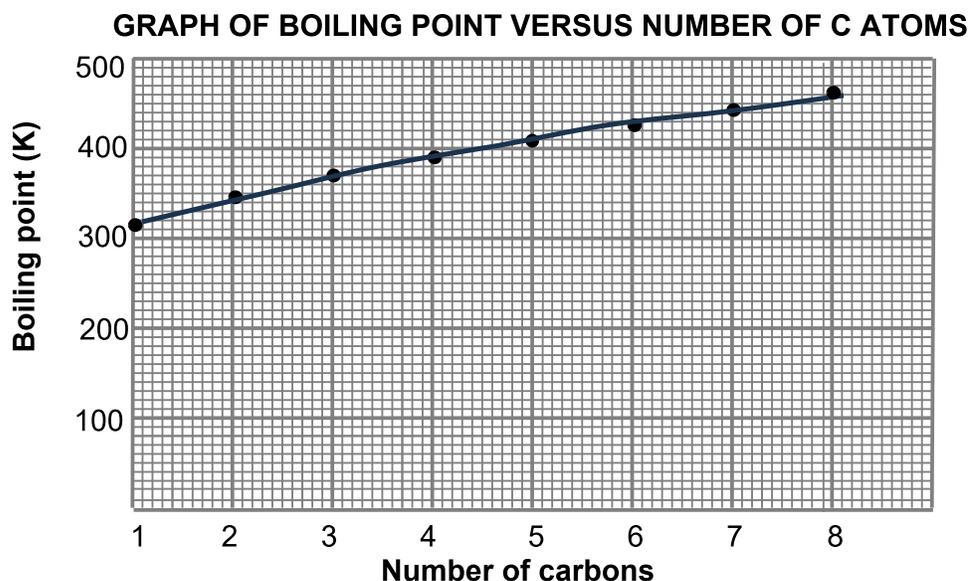
<b>A</b> 3-methylbutanone	<b>B</b> $C_3H_7Cl$
<b>C</b> $  \begin{array}{c}  H & & H \\    & &   \\  H - C & - & C - H \\    & &   \\  H & & H  \end{array}  $	<b>D</b> $  \begin{array}{c}  H & & & & CH_3 \\    & & & &   \\  H - C & - & C \equiv C & - & C - H \\    & & & &   \\  H & & & & CH_2CH_3  \end{array}  $
<b>E</b> $  \begin{array}{c}  H & & H & & O \\    & &   & &    \\  H - C & - & C & - & C - O - H \\    & &   & & \\  H & & H & &   \end{array}  $	

- 2.1 Define *functional group*. (2)
- 2.2 Write down the LETTER of a compound that:
- 2.2.1 Contains a carboxyl group (1)
- 2.2.2 Has the general formula  $C_nH_{2n}O$  (1)
- 2.2.3 Has an empirical formula of  $CH_2$  (1)
- 2.3 How will the molecular mass of compound **E** compare to ethyl methanoate?  
Choose from GREATER THAN, SMALLER THAN or EQUAL TO.  
Give a reason for the answer. (3)
- 2.4 Write down the:
- 2.4.1 STRUCTURAL FORMULA of compound **A** (2)
- 2.4.2 IUPAC name of compound **E** (2)
- 2.4.3 IUPAC name of compound **D** (3)
- 2.5 Compound **B** is a secondary haloalkane.  
Draw the STRUCTURAL FORMULA of compound **B**. (2)
- 2.6 Using the MOLECULAR FORMULAE, write down the balanced equation for the complete combustion of compound **D**. (3)

**[20]**

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

- 3.1 The relationship between boiling point and the number of carbons in STRAIGHT CHAIN PRIMARY ALCOHOLS is investigated. The following curve is obtained:



- 3.1.1 Define *boiling point*. (2)
- 3.1.2 What is the structural similarity between the alcohols that make this a fair investigation? (1)
- 3.1.3 Which van der Waals force is responsible for the trend observed in this curve? (1)
- 3.1.4 Write down the IUPAC name of the alcohol with a boiling point of approximately 410 K. (2)
- 3.2 Another investigation is carried out to determine the effect of structural differences on the boiling point. The table below shows the different compounds and their respective molar mass that was used in this investigation.

COMPOUND		MOLAR MASS (g·mol <sup>-1</sup> )
<b>A</b>	Butanone	72
<b>B</b>	Butan-1-ol	74
<b>C</b>	Propanoic acid	74

- 3.2.1 Which compound **A**, **B** or **C** will have the highest boiling point? (1)
- 3.2.2 Fully explain the answer to QUESTION 3.2.1. (5)

**[12]**

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

4.1 Consider the three organic reactions, **I**, **II** and **III** below:

<b>I</b>	Pent-1-ene + HCl → Organic compound <b>P</b> (Major product)
<b>II</b>	Organic compound <b>P</b> + NaOH → secondary alcohol <b>Q</b> + NaCl
<b>III</b>	Organic compound <b>P</b> + NaOH → Organic compound <b>R</b> + NaCl + H <sub>2</sub> O (Major product)

4.1.1 Is pent-1-ene SATURATED or UNSATURATED? Give a reason for the answer. (2)

Write down the type of reaction represented by:

4.1.2 Reaction **II** (1)

4.1.3 Reaction **III** (1)

Write down the:

4.1.4 STRUCTURAL FORMULA of compound **P**. (2)

4.1.5 IUPAC name of compound **Q**. (2)

4.1.6 Reactions **II** and **III** require the use of a strong base.

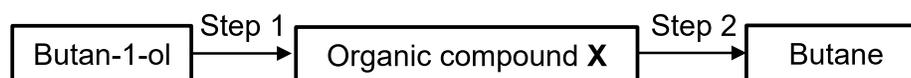
Write down the conditions that will prefer reaction **II** over reaction **III**. (2)

4.1.7 Pent-1-ene and organic compound **R** are isomers.

What type of isomer is pent-1-ene and organic compound **R**?

Choose from FUNCTIONAL, POSITIONAL or CHAIN. (2)

4.2 The flow diagram below shows the conversion of butan-1-ol to butane gas.



The following chemicals are needed:

Concentrated H <sub>2</sub> SO <sub>4</sub>	Pt	H <sub>2</sub>
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Using CONDENSED STRUCTURAL FORMULAE, write down the balanced equation and indicate the chemicals used in each step in the preparation of butane gas from butan-1-ol. (6)

[18]

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

The reaction between EXCESS hydrochloric acid (HCl) with zinc (Zn) is used to investigate factors that influences the reaction rate. The balanced equation for this reaction is:

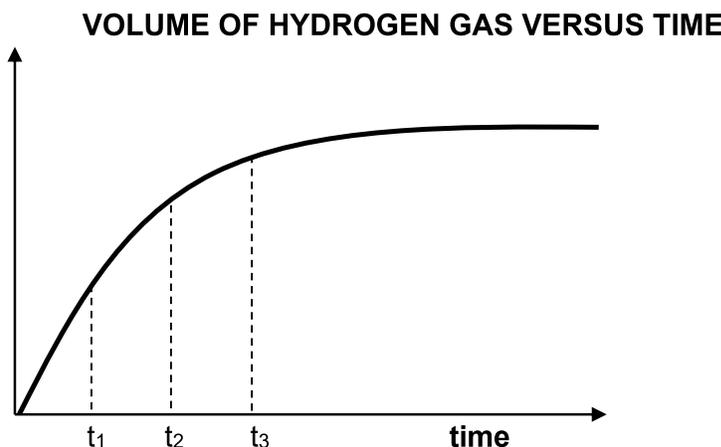


Three experiments are carried out and one factor is changed in each experiment. The same volume of hydrochloric acid and the same mass of zinc granules are used in each experiment. The hydrochloric acid completely covers the zinc in each experiment.

The table below shows the reaction conditions.

EXPERIMENT	CONCENTRATION OF HCl (mol·dm <sup>-3</sup> )	Cu (s) PRESENT
1	0,5	No
2	0,8	No
3	0,5	Yes

- 5.1 Define *reaction rate*. (2)
- 5.2 Write down an investigative question when comparing experiments 1 and 2. (2)
- 5.3 The curve, not drawn to scale, is obtained for the volume of hydrogen gas, H<sub>2</sub> (g) produced over time for experiment 1.



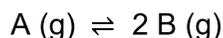
- 5.3.1 How does the rate at which hydrogen gas is produced between t<sub>1</sub>–t<sub>2</sub> compare to that at t<sub>2</sub>–t<sub>3</sub>?

Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

- 5.3.2 Redraw the graph in the ANSWER BOOK. Clearly label the curve as **A**.  
On the same set of axes, sketch the curve that will be obtained for experiment **3**. Label this curve as **B**. (2)
- 5.4 The reaction in experiment **1** takes 58 s to reach completion and the average reaction rate at which hydrogen gas,  $H_2$  is produced is  $8,39 \text{ cm}^3 \cdot \text{s}^{-1}$ .  
Calculate the initial mass of zinc used in each experiment.  
The molar volume for hydrogen gas ( $H_2$ ) at  $25 \text{ }^\circ\text{C}$  is  $24\,000 \text{ cm}^3 \cdot \text{mol}^{-1}$ .  
Experiment **4** is now conducted by increasing the temperature of the reaction mixture in experiment **1**. (5)
- 5.5 How will this change affect the reaction rate?  
Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
- 5.6 Explain the answer to QUESTION 5.5 by referring to the collision theory. (3)
- [16]**

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

6.1 Consider the following hypothetical reaction at equilibrium:



The data in the table below shows the equilibrium concentrations of A (g) and B (g) at different temperatures:

Temperature (°C)	A (mol·dm <sup>-3</sup> )	B (mol·dm <sup>-3</sup> )
200	0,0125	0,843
300	0,171	0,764

6.1.1 State Le Chaterlier's principle. (2)

6.1.2 Is the FORWARD or REVERSE reaction favoured at 200 °C?

Give a reason for the answer. (2)

How will the equilibrium concentration of **A** at 200 °C be affected by the following:

Choose from INCREASES, DECREASES or NO EFFECT

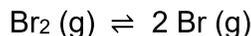
6.1.3 The pressure is increased. (1)

6.1.4 Addition of a suitable catalyst. (1)

6.1.5 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? (1)

6.1.6 Use Le Chatelier's principle and refer to the data in the table to explain the answer to QUESTION 6.1.5. (3)

6.2 Initially 1,05 moles of Bromine (Br<sub>2</sub>) are sealed in an empty container. The following reaction occurs at 1 600 °C.



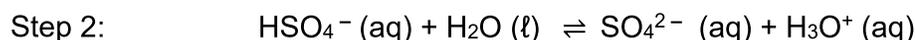
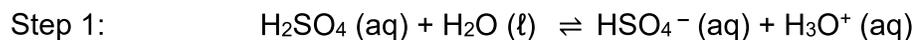
At equilibrium the concentration of Bromine (Br<sub>2</sub>) is 2,074 mol·dm<sup>-3</sup>. The equilibrium constant, K<sub>c</sub> is 6,34 x 10<sup>-4</sup> at 1 600 °C.

Calculate the volume of the container. (7)

**[17]**

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

7.1 Sulphuric acid,  $\text{H}_2\text{SO}_4$  is a strong acid that ionises in two steps as represented by the equations below:



7.1.1 Explain what is meant by *strong acid*. (2)

7.1.2 Give a reason why sulphuric acid is referred to as a diprotic acid. (1)

7.1.3 Write down the conjugate base of  $\text{H}_3\text{O}^+$ . (1)

7.1.4 Write down the FORMULA of the substance that acts as an ampholyte during the ionisation of sulphuric acid. (2)

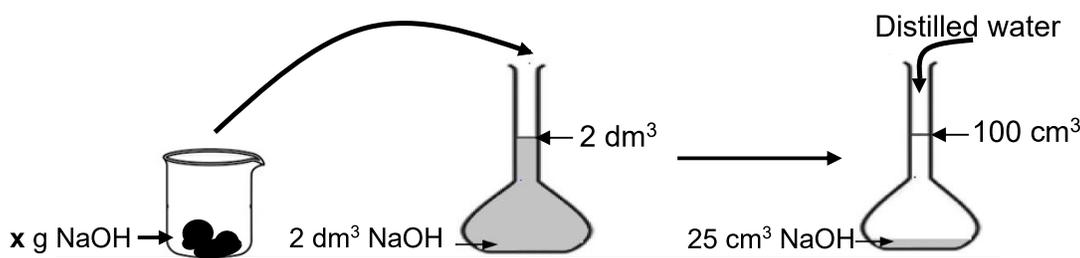
Sulphuric acid has a concentration of  $0,1 \text{ mol} \cdot \text{dm}^{-3}$ .

7.1.5 Calculate the pH value after complete ionisation. (4)

7.2 1,2 g of anhydrous oxalic acid ( $\text{H}_2\text{C}_2\text{O}_4$ ) is dissolved in water to make a  $50 \text{ cm}^3$  solution.

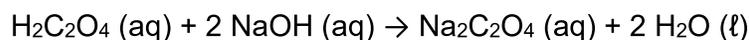
7.2.1 Calculate the concentration of the oxalic acid,  $\text{H}_2\text{C}_2\text{O}_4$ . (3)

Learners dissolve  $x \text{ g}$  of sodium hydroxide,  $\text{NaOH}$  to make a  $2 \text{ dm}^3$  solution of sodium hydroxide,  $\text{NaOH} (\text{aq})$ . They transfer  $25 \text{ cm}^3$  of the sodium hydroxide,  $\text{NaOH}$  solution to a volumetric flask and added distilled water to make a **diluted**  $100 \text{ cm}^3$  solution.



They titrate  $43,8 \text{ cm}^3$  of the **diluted** sodium hydroxide,  $\text{NaOH}$  solution against  $25 \text{ cm}^3$  oxalic acid,  $\text{H}_2\text{C}_2\text{O}_4$  prepared in QUESTION 7.2.1 to reach the endpoint.

The balanced equation is:

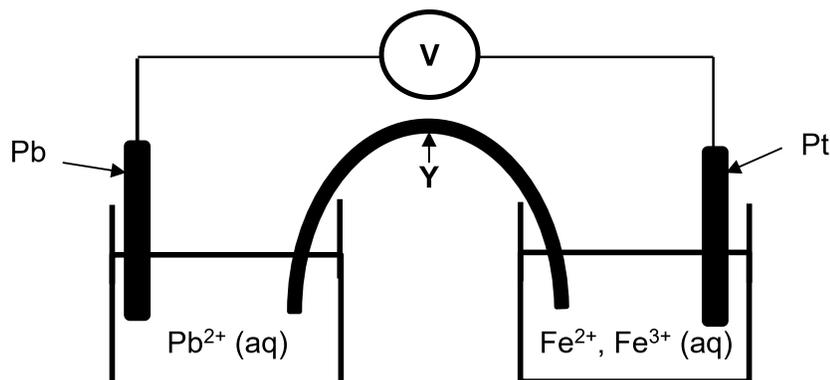


7.2.2 Calculate the mass,  $x \text{ g}$  of sodium hydroxide that was used to make the  $2 \text{ dm}^3$  solution. (7)

**[20]**

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

A standard electrochemical cell is set up as shown below.

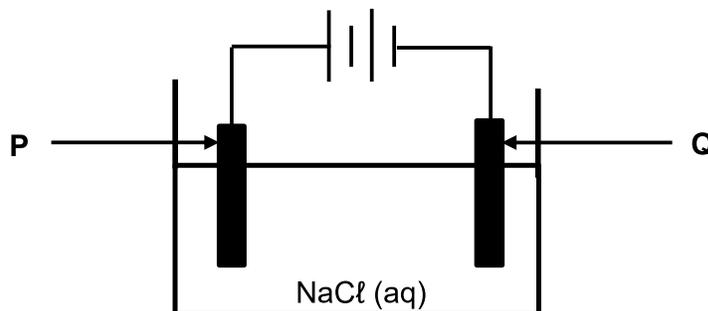


- 8.1 State the energy conversion that takes place in this cell. (2)
- 8.2 Component Y ensures that the cell is complete.  
State ONE other function of component Y. (1)
- 8.3 Write down the reduction half reaction. (2)
- 8.4 Calculate the initial emf of this cell. (4)
- 8.5 How will the reading on the voltmeter be affected, if the:  
Choose from INCREASES, DECREASES or REMAINS THE SAME
- 8.5.1 Initial concentration of  $\text{Pb}^{2+}$  is increased. (1)
- 8.5.2 Surface area of the Pt electrode is increased. (1)
- 8.5.3 The  $\text{Pb} | \text{Pb}^{2+}$  half-cell is replaced with  $\text{Zn} | \text{Zn}^{2+}$ . (1)
- 8.6 Explain the answer to QUESTION 8.5.3 by referring to the relative strength of the reducing agents. (2)

**[14]**

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

A few drops of phenolphthalein are added to concentrated sodium chloride ( $\text{NaCl}$ ) solution. The solution remains colourless. Carbon electrodes **P** and **Q** that are connected to a battery is dipped into the solution as shown below.



- 9.1 Define *electrolysis*. (2)
- 9.2 Write down the name of the component that shows that the above cell is an electrolytic cell. (1)
- 9.3 Write down the NAME or FORMULA of the gas produced at electrode **Q**. (1)
- 9.4 Write down the half reaction that occurs on electrode **P**. (2)
- 9.5 Phenolphthalein is COLOURLESS in an acidic solution and PINK in an alkaline solution.
- Write down the colour of the solution around electrode **Q** and formula of the substance responsible for the colour. (2)
- 9.6 An electrolytic cell is set-up for the purification of copper ( $\text{Cu}$ ) ore that contains zinc ( $\text{Zn}$ ) and platinum ( $\text{Pt}$ ) impurities. After the purification of the impure copper was completed,  $1,38 \times 10^{-2}$  mol of electrons were transferred. The initial mass of the cathode is 2 g.
- 9.6.1 Which metal, besides copper, will be oxidised?  
Choose from zinc or platinum. (1)
- 9.6.2 Calculate the mass of the cathode after the purification. (4)

**[13]****TOTAL: 150**

**NATIONAL SENIOR CERTIFICATE  
NASIONALE SENIOR SERTIFIKAAT**

**DATA FOR PHYSICAL SCIENCES GRADE 12  
PAPER 2 (CHEMISTRY)**

**GEGEWENS VIR FISIESE WETENSAPPE GRAAD 12  
VRAESTEL 2 (CHEMIE)**

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

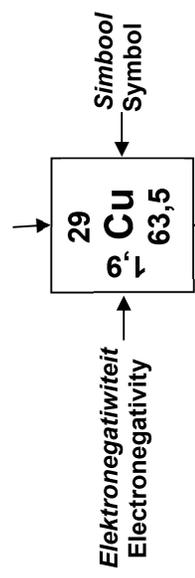
<b>NAAM/NAME</b>	<b>SIMBOOL/SYMBOL</b>	<b>WAARDE/VALUE</b>
Standard pressure <i>Standaarddruk</i>	$p^\theta$	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molêre gasvolume teen STD</i>	$V_m$	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature <i>Standaardtemperatuur</i>	$T^\theta$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

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

$n = \frac{m}{M}$ or/of	$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$n = \frac{N}{N_A}$ or/of	$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$ at /by 298K
$n = \frac{V}{V_m}$		
$E^\theta_{\text{cell}} = E^\theta_{\text{cathode}} - E^\theta_{\text{anode}} / E^\theta_{\text{sel}} = E^\theta_{\text{katode}} - E^\theta_{\text{anode}}$		
$E^\theta_{\text{cell}} = E^\theta_{\text{reduction}} - E^\theta_{\text{oxidation}} / E^\theta_{\text{sel}} = E^\theta_{\text{reduksie}} - E^\theta_{\text{oksidasie}}$		
$E^\theta_{\text{cell}} = E^\theta_{\text{oxidising agent}} - E^\theta_{\text{reducing agent}} / E^\theta_{\text{sel}} = E^\theta_{\text{oksideermiddel}} - E^\theta_{\text{reduseermiddel}}$		
$q = I\Delta t$	$n = \frac{Q}{e}$	or/of $n = \frac{Q}{q_e}$

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

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
(I)	(II)	KEY/SLEUTEL										(III)	(IV)	(V)	(VI)	(VII)	(VIII)	
Atomgetal Atomic number																		
1 H 1	2 He 2	3 Li 3	4 Be 4	5 B 5	6 C 6	7 N 7	8 O 8	9 F 9	10 Ne 10	11 Na 11	12 Mg 12	13 Al 13	14 Si 14	15 P 15	16 S 16	17 Cl 17	18 Ar 18	
19 K 19	20 Ca 20	21 Sc 21	22 Ti 22	23 V 23	24 Cr 24	25 Mn 25	26 Fe 26	27 Co 27	28 Ni 28	29 Cu 29	30 Zn 30	31 Ga 31	32 Ge 32	33 As 33	34 Se 34	35 Br 35	36 Kr 36	
37 Rb 37	38 Sr 38	39 Y 39	40 Zr 40	41 Nb 41	42 Mo 42	43 Tc 43	44 Ru 44	45 Rh 45	46 Pd 46	47 Ag 47	48 Cd 48	49 In 49	50 Sn 50	51 Sb 51	52 Te 52	53 I 53	54 Xe 54	
87 Fr 87	88 Ra 88	89 Ac 89	90 Th 90	91 Pa 91	92 U 92	93 Np 93	94 Pu 94	95 Am 95	96 Cm 96	97 Bk 97	98 Cf 98	99 Es 99	100 Fm 100	101 Md 101	102 No 102	103 Lr 103		
55 Cs 55	56 Ba 56	57 La 57	58 Ce 58	59 Pr 59	60 Nd 60	61 Pm 61	62 Sm 62	63 Eu 63	64 Gd 64	65 Tb 65	66 Dy 66	67 Ho 67	68 Er 68	69 Tm 69	70 Yb 70	71 Lu 71		
133 O 133	137 O 137	139 O 139	140 Ce 140	141 Pr 141	144 Nd 144	149 Pm 149	150 Sm 150	152 Eu 152	157 Gd 157	159 Tb 159	163 Dy 163	165 Ho 165	167 Er 167	169 Tm 169	173 Yb 173	175 Lu 175		
111 O 111	112 O 112	115 O 115	119 O 119	122 O 122	127 O 127	131 O 131	132 O 132	135 O 135	138 O 138	145 O 145	147 O 147	153 O 153	156 O 156	162 O 162	164 O 164	171 O 171		
203 O 203	204 O 204	207 O 207	209 O 209	210 O 210	211 O 211	212 O 212	213 O 213	214 O 214	215 O 215	216 O 216	217 O 217	218 O 218	219 O 219	220 O 220	221 O 221	222 O 222		



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

Half-reactions/Halfreaksies		$E^\theta$ (V)
$F_2(g) + 2e^-$	$= 2F^-$	+ 2,87
$Co^{3+} + e^-$	$= Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$= 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$= Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^-$	$= 2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$= 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$= 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$= Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$= Pt$	+ 1,20
$Br_2(l) + 2e^-$	$= 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$= NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$= Hg(l)$	+ 0,85
$Ag^+ + e^-$	$= Ag$	+ 0,80
$NO_3^- + 2H^+ + e^-$	$= NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$= Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$= H_2O_2$	+ 0,68
$I_2 + 2e^-$	$= 2I^-$	+ 0,54
$Cu^+ + e^-$	$= Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$= S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$= 4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$= Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$= SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$= Cu^+$	+ 0,16
$Sn^{4+} + 2e^-$	$= Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^-$	$= H_2S(g)$	+ 0,14
<b><math>2H^+ + 2e^-</math></b>	<b><math>= H_2(g)</math></b>	<b>0,00</b>
$Fe^{3+} + 3e^-$	$= Fe$	- 0,06
$Pb^{2+} + 2e^-$	$= Pb$	- 0,13
$Sn^{2+} + 2e^-$	$= Sn$	- 0,14
$Ni^{2+} + 2e^-$	$= Ni$	- 0,27
$Co^{2+} + 2e^-$	$= Co$	- 0,28
$Cd^{2+} + 2e^-$	$= Cd$	- 0,40
$Cr^{3+} + e^-$	$= Cr^{2+}$	- 0,41
$Fe^{2+} + 2e^-$	$= Fe$	- 0,44
$Cr^{3+} + 3e^-$	$= Cr$	- 0,74
$Zn^{2+} + 2e^-$	$= Zn$	- 0,76
$2H_2O + 2e^-$	$= H_2(g) + 2OH^-$	- 0,83
$Cr^{2+} + 2e^-$	$= Cr$	- 0,91
$Mn^{2+} + 2e^-$	$= Mn$	- 1,18
$Al^{3+} + 3e^-$	$= Al$	- 1,66
$Mg^{2+} + 2e^-$	$= Mg$	- 2,36
$Na^+ + e^-$	$= Na$	- 2,71
$Ca^{2+} + 2e^-$	$= Ca$	- 2,87
$Sr^{2+} + 2e^-$	$= Sr$	- 2,89
$Ba^{2+} + 2e^-$	$= Ba$	- 2,90
$Cs^+ + e^-$	$= Cs$	- 2,92
$K^+ + e^-$	$= K$	- 2,93
$Li^+ + e^-$	$= Li$	- 3,05

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë

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

Half-reactions/Halfreaksies	$E^{\ominus}$ (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
$2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+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

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