education

Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

SEPTEMBER 2022

MARKS: 150

TIME: 3 HOURS

This question paper consists of 17 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and other applicable information in the appropriate spaces on the ANSWER BOOK.

2. The 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 sub questions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. Show ALL formulae and substitutions in ALL calculations.

9. Round off your FINAL numerical answers to a minimum of TWO decimal places where necessary.

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

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

1.1 Which ONE of the following represents the general formula of the homologous series to which ethanoic acid belongs?

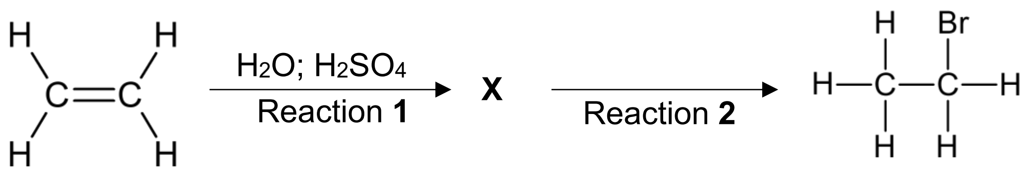
A $C_nH_{2n+2}COOH$

B $C_nH_{2n}COOH$

C $C_nH_{2n+1}COOH$

D $C_nH_{n+2}COOH$ (2)

1.2 Consider reactions **1** and **2** below. **X** is an unknown organic compound.



Reaction **2** is a/an:

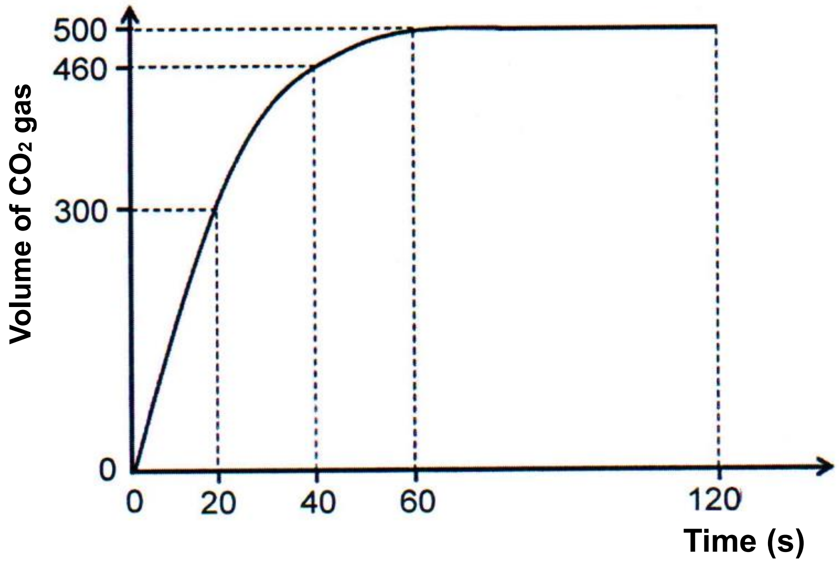
A Substitution

B Halogenation

C Addition

D Hydrohalogenation (2)

1.3 The graph (not drawn to scale) of volume of CO_2 produced versus time during the reaction of $CaCO_3$ with HCℓ is shown below.



Which ONE of the following can be deduced from the graph?

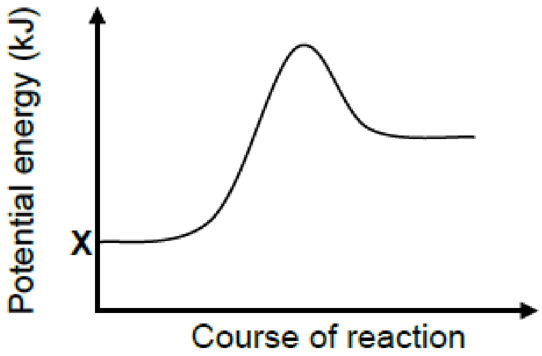
A Equilibrium was reached after 60 s.

B The reaction was completed in 60 s.

C The rate of reaction was increasing between 20 s and 40 s.

D It took 120 s to produce all the CO_2. (2)

1.4 The potential energy diagram for a chemical reaction is shown below.



Consider the following statements regarding the graph above:

I: **X** represents the potential energy of the products formed during the reverse reaction

II: The graph could be a representation of the change in potential energy during the following reaction:

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

III: The graph could be a representation of the change in potential energy during the combustion of ethane

Which of the statements above are TRUE?

A I and II only

B II and III only

C I and III only

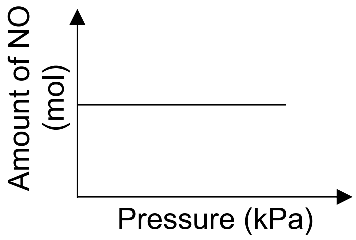
D I, II and III (2)

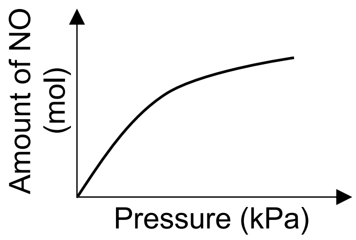
1.5 The reaction between nitrogen gas and oxygen gas reaches equilibrium in a closed container according to the following balanced equation:

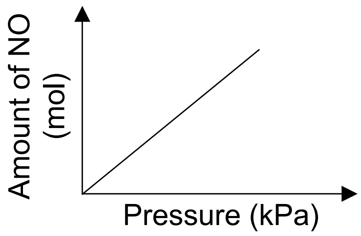
$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$$

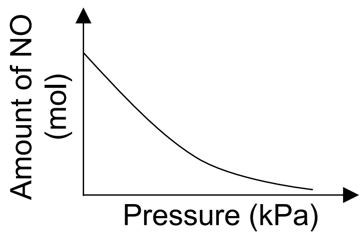
The pressure is gradually increased at constant temperature.

Which ONE of the following graphs shows the relationship between the amount of NO(g) and the pressure in the container while the pressure is increased?

A


B


C


D


(2)

1.6 Consider the equilibrium represented by the balanced equation below:

$$\underset{\text{blue}}{CoC\ell_4^{2-}(aq)} + 6H_2O(\ell) \rightleftharpoons \underset{\text{pink}}{Co(H_2O)_6^{2+}(aq)} + 4C\ell^-(aq) \qquad \Delta H < 0$$

Which ONE of the following will BOTH change the colour of the solution FROM BLUE TO PINK?

A	Add HCℓ	Increase temperature
B	Add HCℓ	Decrease temperature
C	Add water	Increase temperature
D	Add water	Decrease temperature

(2)

1.7 The EQUIVALENCE POINT, when nitric acid is titrated with an ammonium hydroxide solution, is the point where …

A neither the acid nor the base is in excess.

B the concentration of the indicator changes.

C $[H_3O^+] = [OH^-]$.

D the pH = 7. (2)

1.8 Which ONE of the following is the conjugate base of HSO_4^-?

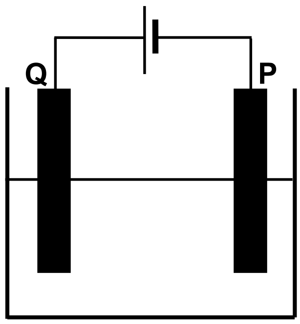
A SO_4^{2-}

B OH^-

C H_2SO_4

D SO_4 (2)

1.9 The simplified diagram below represents an electrochemical cell used for the PURIFICATION of copper.



Consider the following statements regarding this cell.

I Electrode **P** is the cathode.

II Cu^{2+} is reduced to Cu at electrode **Q**.

III The mass of electrode **Q** decreases.

Which of the above statements is/are correct?

A I only

B I and II only

C I and III only

D I, II and III (2)

1.10 Consider the half-reactions and their respective reduction potentials shown below.

Reduction half-reaction	**E^θ (V)**
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$Fe^{3+} + e \rightleftharpoons Fe^{2+}$	+ 0,77
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	- 0,41
$Zn^{2+} + e^- \rightleftharpoons Zn$	- 0,76

Which ONE of the following statements is correct?

A Fe^{3+} can reduce acidified MnO_4^- to Mn^{2+}.

B Zn can oxidise acidified Cr^{2+} to Cr^{3+}.

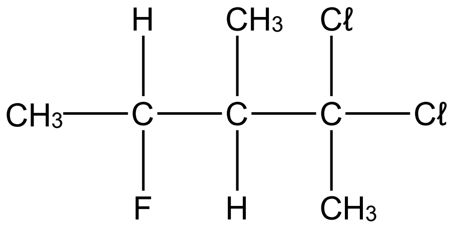
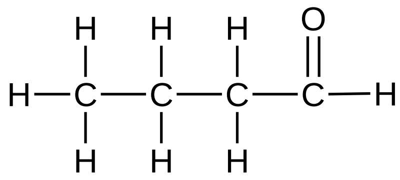
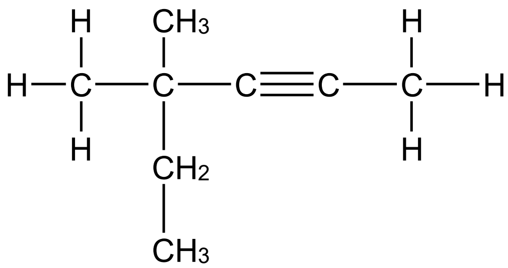
C Zn^{2+} can reduce acidified $Cr_2O_7^{2-}$ to Cr^{2+}.

D Cr^{2+} can reduce Fe^{3+} to Fe^{2+}. (2)

[20]

QUESTION 2 (Start on a new page.)

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

A		**B**	
C	$CH_3CH_2COCH_3$	**D**	$CH_3CH(OH)CH_3$
E	Propan-1-ol	**F**	

2.1 Define the term *secondary alcohol*. (2)

2.2 Write down the letter(s) that represent(s):

2.2.1 A secondary alcohol (1)

2.2.2 An alkyne (1)

2.2.3 Two compounds that are functional isomers (1)

2.3 For compound **B**, write down the:

2.3.1 Name of its functional group (1)

2.3.2 Structural formula of its chain isomer (2)

2.4 Compounds **D** and **E** are structural isomers.

2.4.1 Define the term *structural isomer.* (2)

2.4.2 Identify the TYPE of structural isomerism. (1)

2.5 Write down the IUPAC name of:

2.5.1 Compound **A** (3)

2.5.2 Compound **D** (2)

2.5.3 Compound **F** (2)

[18]

QUESTION 3 (Start on a new page.)

The relationship between boiling point and the TYPE of organic compound is investigated. The results obtained are shown in the table below. **X** is an unknown boiling point.

COMPOUND	MOLECULAR MASS	BOILING POINT (°C)
Pentane	72	36,1
Butanone	72	79,6
Propanoic acid	74	141,2
Butan-1-ol	74	**X**

3.1 Define the term *boiling point* (2)

3.2 Refer to the TYPE of intermolecular forces to explain the difference in boiling points of pentane and butanone. (4)

3.3 The table below shows possible values for **X**, the boiling point of butan-1-ol, in degrees Celsius (°C).

78,6	117,7	141,4

3.3.1 Predict the value of **X**. (1)

3.3.2 Fully explain your choice in QUESTION 3.3.1. (4)

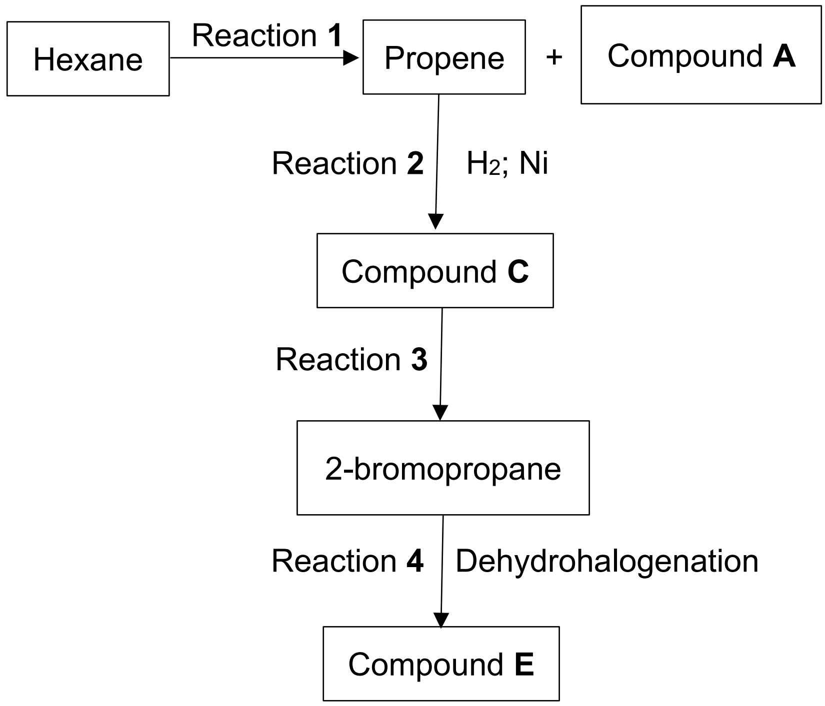
3.4 Boiling points of butan-1-ol and propanoic acid are compared.

3.4.1 Is this a fair comparison? (1)

3.4.2 Write down the reason for the answer in QUESTION 3.4.1. (1)
[13]

QUESTION 4 (Start on a new page.)

4.1 The flow diagram below shows how various organic compounds can be prepared using hexane as starting reagent.



4.1.1 Write down the type of reaction represented by:

(i) **Reaction 1** (1)

(ii) **Reaction 2** (1)

(iii) **Reaction 3** (1)

4.1.2 Write down the MOLECULAR FORMULA of compound **A.** (1)

4.1.3 State the function of nickel in **reaction 2**. (1)

4.1.4 Using STRUCTURAL FORMULAE, write down the balanced equation for **reaction 3**. (4)

4.1.5 Write down the IUPAC name of compound **E**. (1)

4.2 Propyl ethanoate can be prepared from 1-bromopropane by a two-step process as shown in the flow diagram below.

1-bromopropane → (**Step 1**) → Compound **A** → (**Step 2**) → Propyl ethanoate

4.2.1 Using CONDENSED STRUCTURAL FORMULAE, write down a balanced equation for **step 1**. Indicate the reaction conditions on the arrow. (4)

4.2.2 Write down the IUPAC name of compound **A**. (2)

In **step 2**, compound **A** reacts with another organic compound.

Write down:

4.2.3 The type of reaction that takes place (1)

4.2.4 The STRUCTURAL FORMULA of the other organic reactant needed (2)

4.2.5 ONE reaction condition needed (1)
[20]

QUESTION 5 (Start on a new page.)

A group of learners use the reaction of zinc (Zn) with EXCESS hydrochloric acid (HCℓ) to investigate factors which influence reaction rate. The balanced equation for the reaction is:

$$Zn(s) + 2HCℓ(aq) \rightarrow ZnCℓ_2(aq) + H_2(g)$$

They use the same volume of hydrochloric acid and 1 g of zinc at a temperature of 20 °C in each of four experiments. Some of the reaction conditions used in each experiment are summarised in the table below. The time recorded in the table is that for the reaction to run to completion.

Experiment	**REACTION CONDITIONS**		**Time (s)**
	Concentration of HCℓ (mol·dm^{-3})	**State of division of Zn**	
1	0,6	granules	40
2	0,6	powder	9
3	0,8	powder	5
4	0,6	granules	10

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

5.2 Give a reason for the difference in reaction rate observed in Experiments **1** and **2**. (1)

5.3 The learners compare the results of Experiments **1** and **3** to draw a conclusion regarding the effect of CONCENTRATION on reaction rate. Give a reason why this is NOT a fair comparison. (1)

5.4 The reaction rates of Experiments **1** and **4** are compared.

5.4.1 How does the reaction rate in Experiment **4** compare to that in Experiment **1**? Choose from HIGHER THAN, LOWER THAN or EQUAL TO. (1)

5.4.2 State the factor involved and fully explain the answer to QUESTION 5.4.1 by referring to the collision theory. (4)

5.5 Calculate the average rate, in mol·s^{-1}, at which the hydrochloric acid reacts in Experiment **2**. (6)

[15]

QUESTION 6 (Start on a new page.)

The reaction of hydrogen, $H_2(g)$, with nitrogen, $N_2(g)$, reaches equilibrium in a closed container according to the following balanced equation.

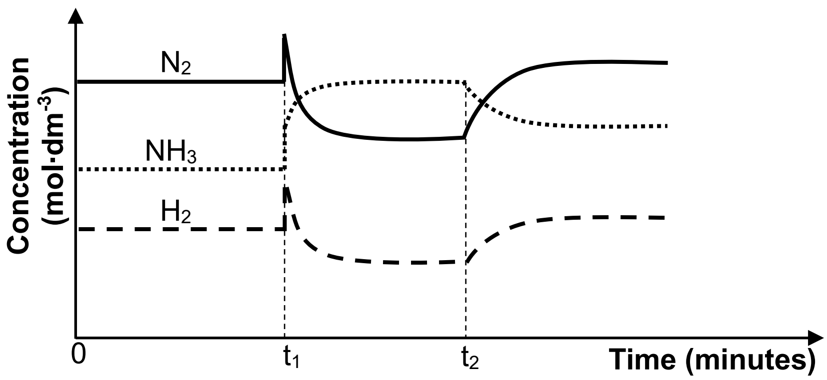
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

6.1 Write down the meaning of the term *reversible reaction*. (1)

6.2 Give TWO features of a reaction that has reached equilibrium. (2)

6.3 Give a reason why a catalyst has no effect on the position of an equilibrium. (1)

6.4 The graph below, not drawn to scale, shows how the concentrations of the three gases change because of changes made to the reaction conditions.



6.4.1 State the change made to the reaction conditions at time t_1. (1)

6.4.2 Use Le Chatelier's principle to explain the EFFECT of the change stated in QUESTION 6.4.1. (2)

6.4.3 State the change made to the reaction conditions at time t_2. (1)

6.4.4 Use Le Chatelier's principle to explain the EFFECT of the change stated in QUESTION 6.4.3. (2)

6.5 The above reaction reaches equilibrium in a closed 10 dm^3 container at temperature T. The K_c value is found to be 68.

Calculate the initial number of moles of H_2 when the equilibrium mixture contains 3,82 mol of N_2 and 5,24 mol of NH_3. (8)

[18]

QUESTION 7 (Start on a new page.)

7.1 Ammonium hydroxide, NH_4OH, is a weak base.

7.1.1 Define the term *weak base.* (2)

7.1.2 An ammonium hydroxide solution has a pH of 10,09 at 25 °C. Calculate the concentration of the hydronium ions, $H_3O^+(aq)$, in the solution. (3)

Ammonium chloride, $NH_4C\ell$, forms when ammonium hydroxide reacts with hydrochloric acid.

7.1.3 Will the pH of an ammonium chloride solution be GREATER THEN 7, SMALLER THAN 7 or EQUAL TO 7? (1)

7.1.4 Explain the answer to QUESTION 7.1.3 with the aid of a balanced chemical equation. (3)

7.2 A 2,5 g impure sample of zinc (Zn) is added to 25 cm^3 of a 1 $mol \cdot dm^{-3}$ sulphuric acid, H_2SO_4, solution. The balanced equation for the reaction is:

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

On completion of the reaction, the EXCESS sulphuric acid is neutralised by 15 cm^3 of a 0,5 $mol \cdot dm^{-3}$ sodium hydroxide solution. The balanced equation for the reaction is:

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$$

7.2.1 Calculate the number of moles of sulphuric acid that was in EXCESS. (3)

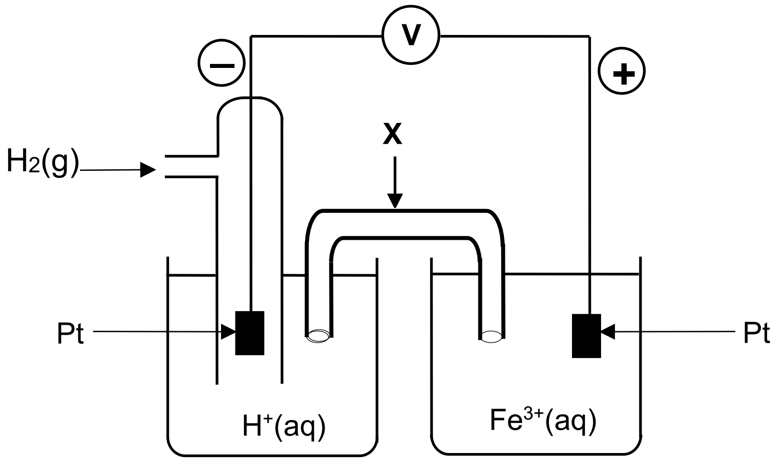
7.2.2 Calculate the percentage impurities in the zinc. (8)

[20]

QUESTION 8 (Start on a new page.)

8.1 The diagram below shows a cell that can be used to measure the STANDARD electrode potential for the following half-reaction:

$$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$$



8.1.1 Define the term *reducing agent* in terms of electron transfer. (2)

8.1.2 Write down the NAME or FORMULA of the strongest reducing agent in the above cell. (1)

8.1.3 Component **X** completes the circuit in the cell. State ONE other function of component **X**. (1)

8.1.4 State ONE condition for this cell to operate under standard conditions. (1)

8.1.5 Give a reason why platinum is suitable to function as electrodes in this cell. (1)

8.1.6 Write down the cell notation for the above cell. (3)

8.1.7 Calculate the initial voltmeter reading of this cell under standard conditions. (4)

8.1.8 The reading on the voltmeter becomes ZERO after this cell operates for several hours. Give a reason for this reading by referring to the rates of the oxidation and reduction half-reactions taking place in the cell. (1)

8.2 Is it advisable to store an iron(III) solution in a container made of tin (Sn)? Choose from YES or NO. Fully explain the answer by referring to the relative strengths of reducing agents. (4)

[18]

QUESTION 9 (Start on a new page.)

The simplified diagram below represents a cell used for the electrolysis of a concentrated sodium chloride solution, NaCℓ(aq).
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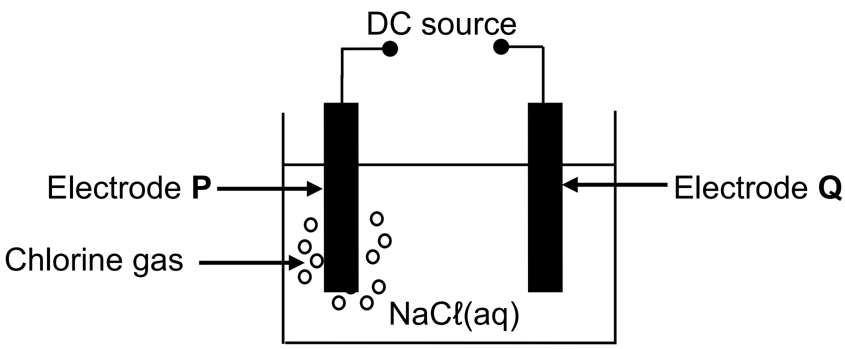

9.1 Define the term *electrolysis*. (2)

9.2 Which electrode (**P** or **Q**) is positive? (1)

9.3 Write down the half-reaction taking place at electrode **P**. (2)

9.4 Write down the overall (net) cell reaction that takes place in this cell. (3)
[8]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

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

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

TABLE 2: FORMULAE / *TABEL 2: FORMULES*

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

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

KEY/*SLEUTEL*

	Atomic number *Atoomgetal*	
Electronegativity *Elektronegatiwiteit*	29 1,9 Cu 63,5	Symbol *Simbool*
	Approximate relative atomic mass *Benaderde relatiewe atoommassa*	

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

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

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

Half-reactions / *Halfreaksies*			E^{θ} (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
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 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
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 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
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	⇌	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
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 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 strength of reducing agents / *Toenemende sterkte van reduseermiddels* (↓)

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

Increasing strength of oxidising agents / *Toenemende sterkte van oksideermiddels* (↓)

Increasing strength of reducing agents / *Toenemende sterkte van reduseermiddels* (↑)

Half-reactions / *Halfreaksies*			E^{θ} (V)
$Li^+ + e^-$	⇌	Li	− 3,05
$K^+ + e^-$	⇌	K	− 2,93
$Cs^+ + e^-$	⇌	Cs	− 2,92
$Ba^{2+} + 2e^-$	⇌	Ba	− 2,90
$Sr^{2+} + 2e^-$	⇌	Sr	− 2,89
$Ca^{2+} + 2e^-$	⇌	Ca	− 2,87
$Na^+ + e^-$	⇌	Na	− 2,71
$Mg^{2+} + 2e^-$	⇌	Mg	− 2,36
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	− 1,66
$Mn^{2+} + 2e^-$	⇌	Mn	− 1,18
$Cr^{2+} + 2e^-$	⇌	Cr	− 0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	⇌	Zn	− 0,76
$Cr^{3+} + 3e^-$	⇌	Cr	− 0,74
$Fe^{2+} + 2e^-$	⇌	Fe	− 0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	⇌	Cd	− 0,40
$Co^{2+} + 2e^-$	⇌	Co	− 0,28
$Ni^{2+} + 2e^-$	⇌	Ni	− 0,27
$Sn^{2+} + 2e^-$	⇌	Sn	− 0,14
$Pb^{2+} + 2e^-$	⇌	Pb	− 0,13
$Fe^{3+} + 3e^-$	⇌	Fe	− 0,06
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87