# Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

## PHYSICAL SCIENCES P2 (CHEMISTRY)

## PREPARATORY EXAMINATION

## SEPTEMBER 2016

**NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**MARKS : 150**

**TIME : 3 Hours**

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

## INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.
2. The question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave one line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable pocket 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 where applicable.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

## QUESTION 1: MULTIPLE – CHOICE QUESTIONS

**Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.10) in your ANSWER BOOK.**

1.1 The main product of the Ostwald process is ...

A ammonia.
B ammonium nitrate.
C nitric acid.
D sulphuric acid. (2)

1.2 A polymer formed as a result of addition polymerisation is most likely to be derived from a monomer that is ...

A An ester
B A hydrocarbon
C An alcohol
D A carboxylic acid (2)

1.3 Which one of the following compounds is an isomer of propanoic acid?

A propan -1,2,3 - triol
B 2 - methylpropan -1 - ol
C ethyl ethanoate
D methyl ethanoate (2)

1.4 The boiling points of helium and argon are – 269 °C and – 186 °C respectively. The difference in boiling point is due to the presence of stronger ...

A ionic bonds between argon atoms.
B Van der Waals forces between argon atoms.
C hydrogen bonds between helium atoms.
D covalent bonds between helium atoms. (2)

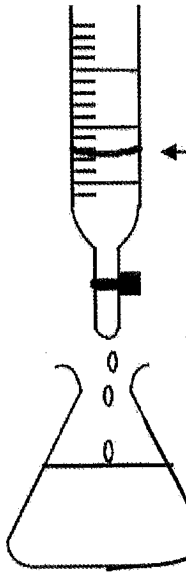
1.5 When a base **X** is titrated against an acid **Y**, the pH of the solution at the end point is found to be 9.

The base **X** and acid **Y** could be:

| | X | Y |
|---|---|---|
| A | NaOH | $CH_3COOH$ |
| B | $Na_2CO_3$ | HCl |
| C | NaOH | $H_2SO_4$ |
| D | $Na_2CO_3$ | $CH_3COOH$ |

(2)

1.6 A group of learners were doing a titration using HCl and NaOH, as shown below. They accidentally exceeded the endpoint.




Which one of the following could be **correct** for the solution now in the flask?

A $[H^+] < [OH^-]$ and pH < 7
B $[H^+] = [OH^-]$ and pH < 7
C $[H^+] > [OH^-]$ and pH < 7
D $[H^+] > [OH^-]$ and pH = 7 (2)

1.7 One of the stages in the industrial preparation of iron from its ore is represented by the equation below:

$$Fe_2O_3(s) + 3CO(g) \rightleftharpoons 2Fe(s) + 3CO_2(g)$$

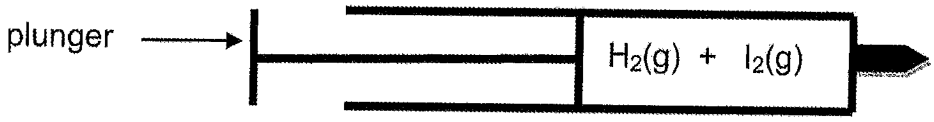
Which one of the following changes will favour the forward reaction?

A $Fe_2O_3$ is added
B $CO_2$ is removed
C CO is removed
D A suitable catalyst is added (2)

1.8 A mixture of $H_2(g)$ and $I_2(g)$ is sealed in a gas syringe. The mixture is then allowed to reach equilibrium at a constant temperature according to the equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$



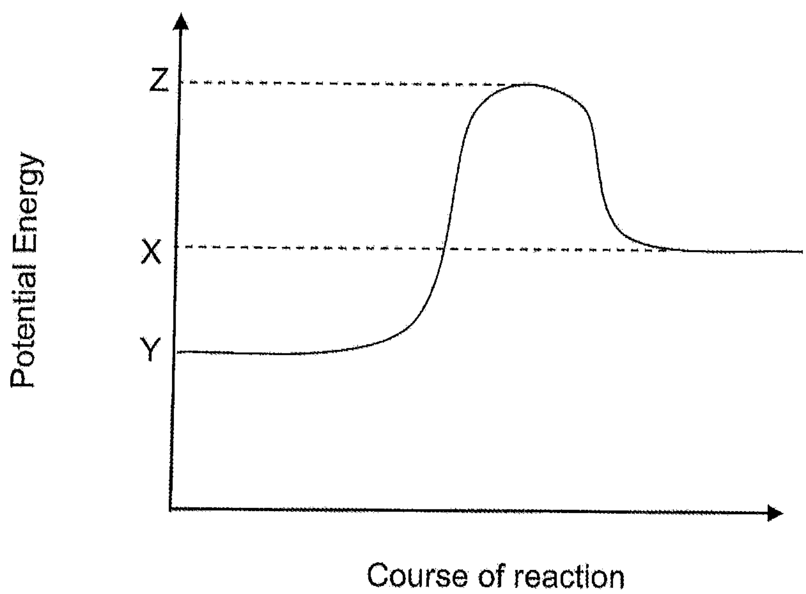

What will happen to the **concentration and yield** of HI if the plunger is moved inwards (pushed to the right) while the temperature remains constant?

| | [HI] | Yield of HI |
|---|---|---|
| A | Increases | Stay the same |
| B | Decreases | Stay the same |
| C | Decreases | Increases |
| D | Increases | Decreases |

(2)

1.9 Consider the potential-energy diagram for the reaction:

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$




Which one of the following statements is **correct**?

A X represents the energy of $CaCO_3$
B Y represents the energy of $CaO + CO_2$
C X represents the energy of $CaO + CO_2$
D Z represents a catalyst

(2)

1.10 When $H_2S$ gas is bubbled into a solution of acidified $MnO_4^-$, the following unbalanced reaction occurs:

$$MnO_4^- + H_2S + H^+ \rightarrow Mn^{2+} + S + H_2O$$

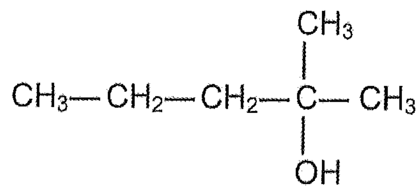
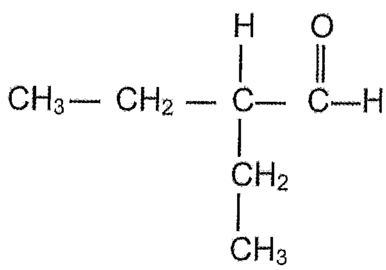
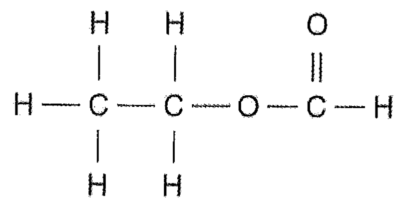
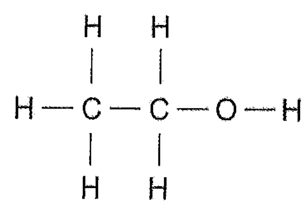
The oxidising agent in this reaction is:

A $H_2S$
B $Mn^{2+}$
C S
D $MnO_4^-$ (2)

**[20]**

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

Consider the following representation of organic compounds **A** to **H** listed in the table below to answer the questions that follow:

| | | | |
|---|---|---|---|
| **A** | Butan-2-ol | **B** | Pentanal |
| **C** |  | **D** | $CH_2 = CH - Cl$ |
| **E** |  | **F** |  |
| **G** | 4-methylpentanoic acid | **H** |  |

2.1 Write down ONLY the letter of the compound that is:

2.1.1 used in the laboratory preparation of **F**. (2)

2.1.2 a SECONDARY alcohol? (1)

2.1.3 an UNBRANCHED aldehyde. (1)

2.2 Write down the IUPAC name for:

2.2.1 compound **D**. (2)

2.2.2 compounds **C**. (2)

2.3 Draw the STRUCTURAL FORMULA of compound **G**. (2)

**[10]**

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

3.1 The boiling point of methane is -161° C and the boiling point of pentane is 36° C. Rama, a learner, explains why the boiling points of pentane and methane are different as follows:

*"Pentane has a longer carbon chain than methane therefore more bonds need to be broken to separate the molecule into its individual atoms. Breaking of these bonds requires energy which explains why pentane has a higher boiling point than methane."*

3.1.1 Give a reason why his explanation is **INCORRECT**. (1)

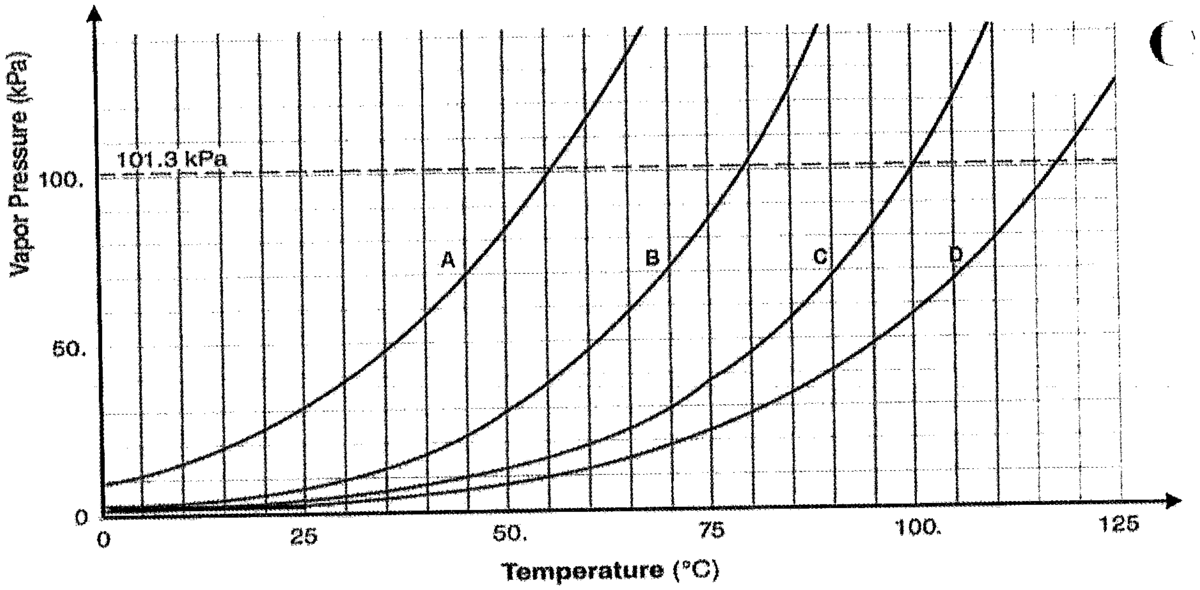
3.1.2 Explain fully why the boiling points of pentane and methane are different. (3)

3.1.3 Write down the NAME and draw the STRUCTURAL FORMULA of an isomer of pentane which has a lower boiling point than pentane. (3)

The following graph shows the relationship between vapour pressure of some organic compounds and temperature. The ***dotted line*** indicates the external atmospheric pressure, and C is the graph for water.

The three curves (**A**, **B** and **D**) represents the following UNBRANCHED compounds with the same number of carbon atoms:
**alcohol, carboxylic acid and a ketone.**

**VAPOUR PRESSURE OF COMPOUNDS AT DIFFERENT TEMPERATURES**



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

3.3 Which ONE of the curves (**A**, **B** or **D**) represents the

3.3.1 Carboxylic acid (2)

3.3.2 Ketone (2)

3.4 Fully EXPLAIN your choice in QUESTION 3.3.1 by referring to the TYPE and STRENGTH of the INTERMOLECULAR FORCES. (3)
**[16]**

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

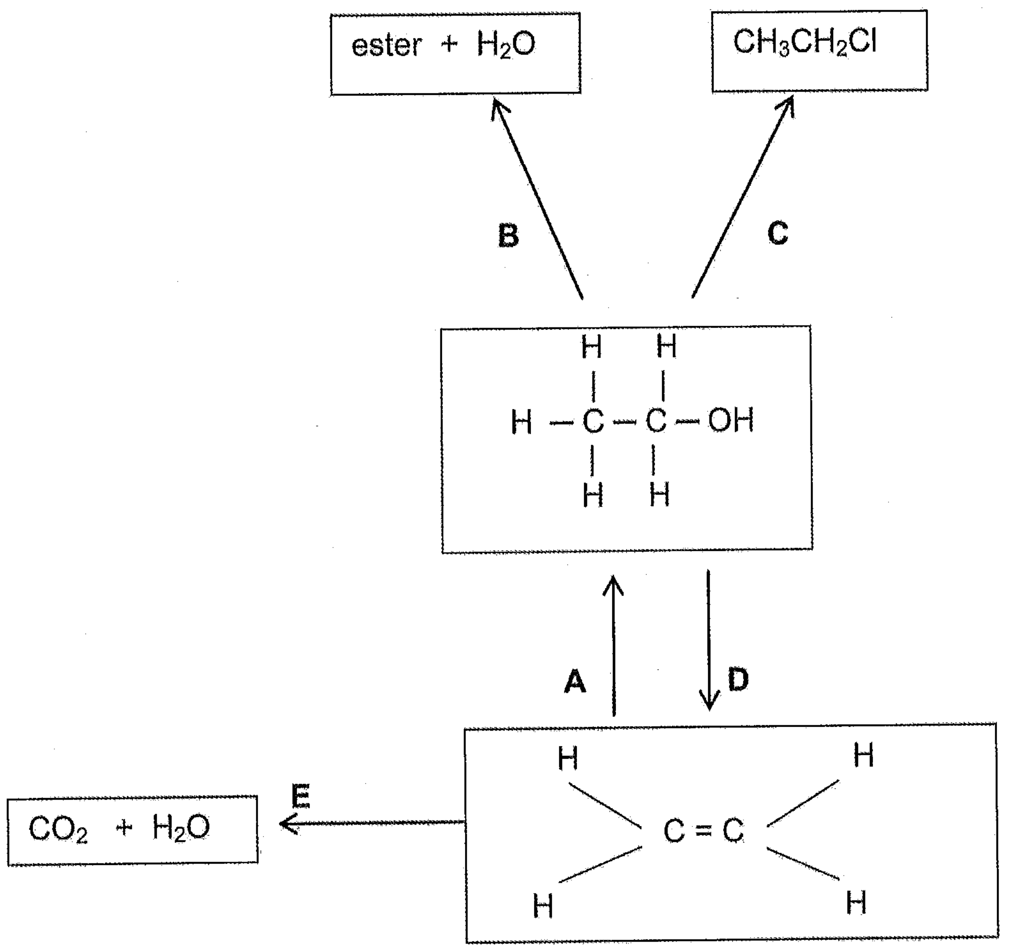
4.1 A group of Grade 12 learners are in a school laboratory preparing an ester using methanol and ethanoic acid. The balanced chemical equation for this reaction is given below:

$$CH_4O + C_2H_4O_2 \rightarrow C_3H_6O_2 + H_2O$$

4.1.1 Write down the IUPAC name of the ester formed. (2)

4.1.2 When 50 g of impure methanol fully reacts with excess ethanoic acid, it produces 68,88 g $C_3H_6O_2$. Calculate the percentage purity of the methanol. (5)

4.2 Consider the following organic compounds and reactions.




4.2.1 Name the type of reaction indicated by A, C, D and E. (4)

4.2.2 The product of reaction C can be converted, by a single reaction, to the product of reaction D. State the necessary reagents and reaction conditions for this conversion to take place. (3)

4.2.3 Reactions B and D use the same dehydrating agent. Write down the NAME or FORMULA of this dehydrating agent. (1)

4.2.4 The product of reaction D can undergo polymerization. Name the polymer that will be produced. (1)

The product of reaction D is one of two products formed when $C_6H_{14}$ undergoes thermal cracking.

4.2.5 Explain what is meant by thermal cracking. (2)

4.2.6 Write down the molecular formula of the other product formed. (2)

**[20]**

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

Ketiwe conducts an experiment to investigate the various factors that influence the rate of chemical reactions. She places a sample of calcium carbonate in a beaker. The beaker is placed on a sensitive balance and an excess of hydrochloric acid (HCl) is added. The following reaction occurs:

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

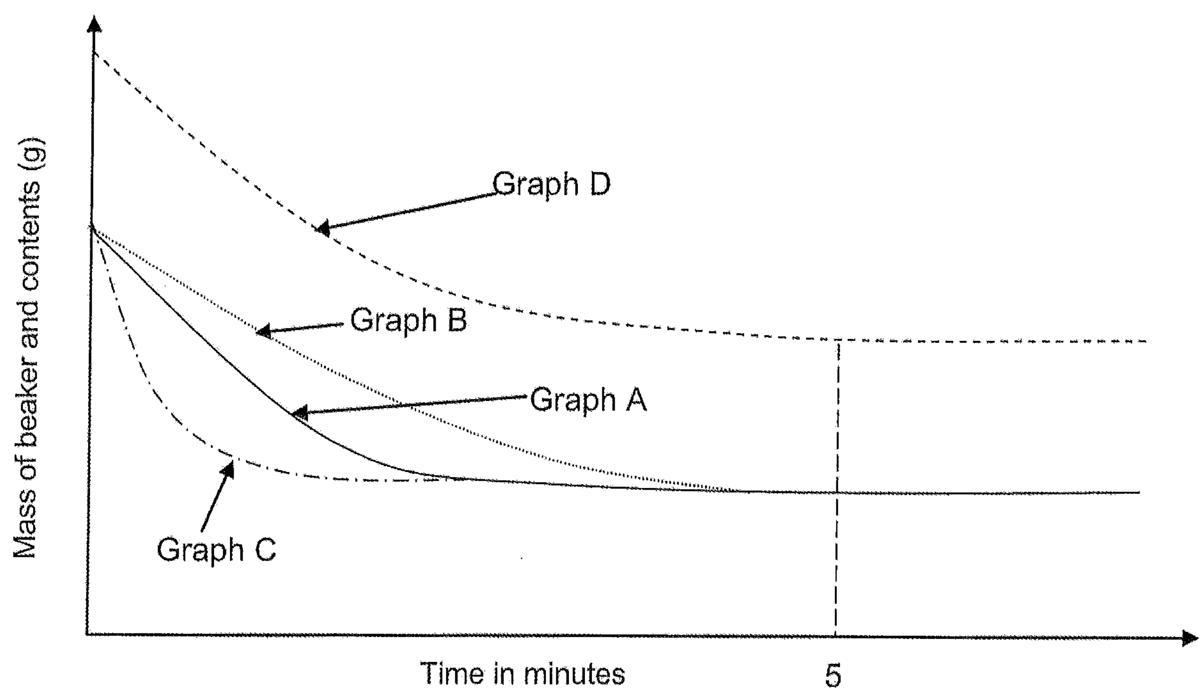
Ketiwe repeats the experiment a number of times under different conditions, always with the same volume of HCl, which remains in excess.

The following table summarizes the different experimental conditions for four of her experiments.

| **Expt** | **Mass of $CaCO_3$ (g)** | **Concentration of HCl ($mol{\cdot}dm^{-3}$)** | **Temperature of HCl (°C)** | **State of $CaCO_3$** |
|---|---|---|---|---|
| 1 | 10 | 2 | 25 | granules |
| 2 | 10 | 2 | 15 | granules |
| 3 | 20 | 2 | 25 | granules |
| 4 | 10 | 2 | 25 | powder |

During each experiment the mass of the beaker and its contents is recorded every minute.

The graphs below indicate the changes in mass of the beaker and its contents during the reaction, as a function of time, for the four experiments, Graph A represents the results of Experiment 1.



5.1 What is meant by the '*rate of a chemical reaction*'? (2)

5.2 Name the factor that was kept constant in all 4 experiments. (1)

5.3 Give a reason for the decrease in mass as each reaction progresses. (2)

5.4 Why are all the graphs horizontal lines after five minutes? (2)

5.5 Which one of the graphs (B, C, or D) represents the results of:

5.5.1 Experiment 2 (1)

5.5.2 Experiment 3 (1)

5.5.3 Experiment 4 (1)

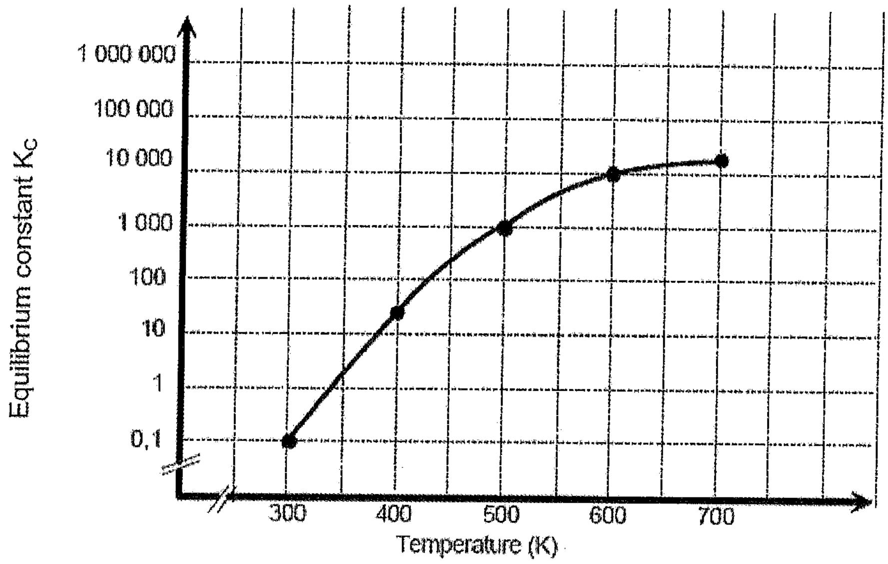
5.6 If a suitable catalyst is used in experiment 1, which of the graphs (B, C, or D) will be obtained? Explain your answer. (4)

5.7 What effect will the catalyst have on the amount of $CO_2$ formed? Choose from INCREASES, DECREASES OR REMAINS THE SAME. (1)
**[15]**

## QUESTION 6 (Start on a new page)

6.1 The graph below shows the effect of a temperature change on the value of $K_c$ for the following reaction taking place in a closed container:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$




6.1.1 When the temperature increases will the equilibrium constant ($K_c$) INCREASE , DECREASE OR STAY THE SAME? (1)

6.1.2 State Le Chatelier's Principle. (2)

6.1.3 Using Le Chatelier's Principle, explain whether the forward reaction is EXOTHERMIC or ENDOTHERMIC. (4)

6.1.4 Write down TWO factors, other than temperature, that can be used to increase the rate of the forward reaction at 500K. (2)

6.2 Consider the hypothetical reaction that takes place between gases $A_2$ and B in a closed container.

| $A_2(g)$ | + | $2B(g)$ | $\rightleftharpoons$ | $2AB(g)$ | $\Delta H > 0$ |
|---|---|---|---|---|---|
| colourless | | colourless | | dark red | |

**X** mol of gas $A_2$ and 2,0 mol of gas B are sealed in a 1,0 $dm^3$ container. After a few minutes equilibrium is reached and the contents of the container turns light red.

At equilibrium it is found that 0,40 mol of gas AB is present in the container. The value of $K_c$ is 0,50.
Determine **X**, the quantity (in mol) of gas $A_2$ that was originally sealed in the container. (8)

**[17]**

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

7.1 Magnesium hydroxide ($Mg(OH)_2$) is often used to relieve an upset stomach. The pH of the $HC\ell(aq)$ in a person's stomach is 1.

7.1.1 Calculate the concentration of the hydrochloric acid in the person's stomach. (3)

7.1.2 Will the pH in the stomach **INCREASE, DECREASE** or **STAY THE SAME** after taking a dose of $Mg(OH)_2$? (1)

7.1.3 A person takes a dose of $Mg(OH)_2$. Write down the balanced equation for the reaction that takes place in the stomach. (3)

7.2 Explain what is meant by a neutralization reaction. (2)

7.3 12 $cm^3$ of NaOH of concentration 0,1 $mol{\cdot}dm^{-3}$ and 48 $cm^3$ of $Ba(OH)_2$ of unknown concentration are mixed in a large flask, and the solution is homogenized. This solution is completely neutralized by 54 $cm^3$ of a 0,05 $mol{\cdot}dm^{-3}$ $H_2SO_4$ solution. Calculate the concentration of the $Ba(OH)_2$ solution. (8)

**[17]**

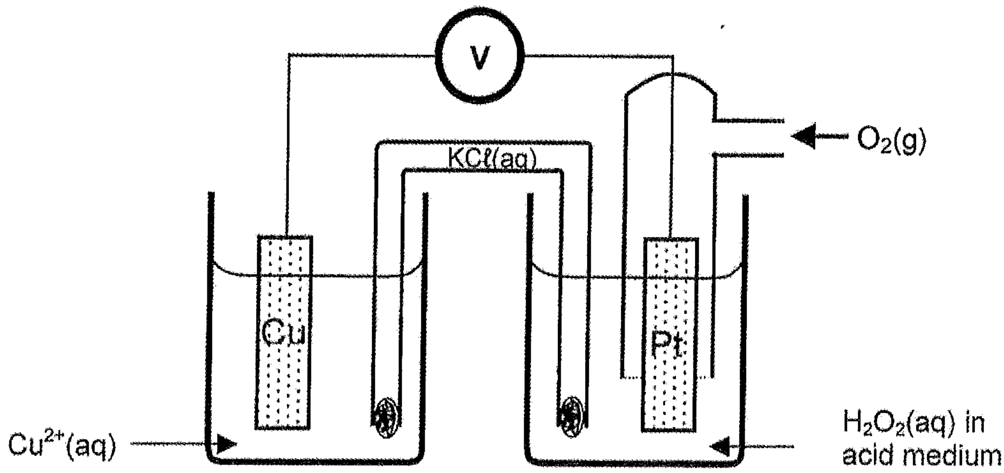
## QUESTION 8 (Start on a new page.)

8.1 A group of learners set up a standard electrochemical cell using the following half – cells:

$$Pt, O_2(g), H^+(aq) \mid H_2O_2(aq) \text{ and}$$

$$Cu^{2+}(aq) \mid Cu(s)$$

Potassium chloride (KCl) solution is used in the salt bridge.




8.1.1 Which electrode is the cathode? (1)

8.1.2 Write down the oxidation half-reaction. (2)

8.1.3 Write down the reduction half-reaction. (2)

8.1.4 Calculate the initial emf of the cell. (4)

8.2 A second group of learners set up another standard electrochemical cell using the following half-reactions:

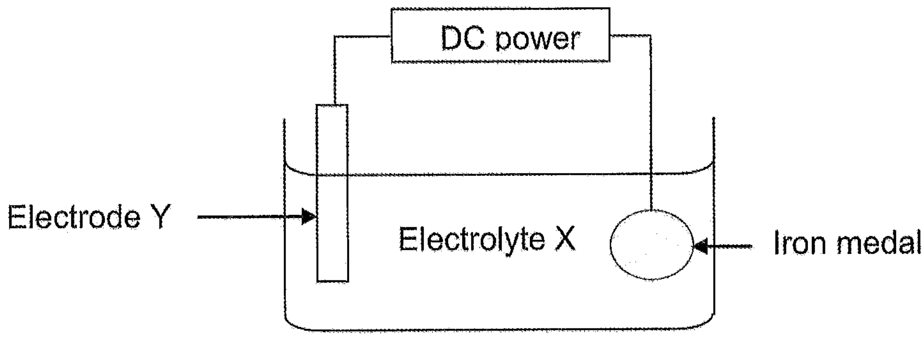
| | |
|---|---|
| $Ce^{3+} + 3e^- \rightarrow Ce$ | $E^\ominus = -2{,}30$ V |
| $Pd^{2+} + 2e^- \rightarrow Pd$ | $E^\ominus = +0{,}99$ V |

Write the balanced equation for the nett overall reaction. (3)

**[12]**

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

The simplified diagram below shows an electrolytic cell used at an electroplating company to coat iron medals with silver.




9.1 Write down the energy conversion that takes place in this cell. (1)

9.2 What physical change takes place at electrode Y when the cell is in operation? (2)

9.3 Which type of reaction (OXIDATION or REDUCTION) takes place at electrode Y? (1)

9.4 Write down the:

9.4.1 Equation for the half-reaction that takes place at the iron medal (2)

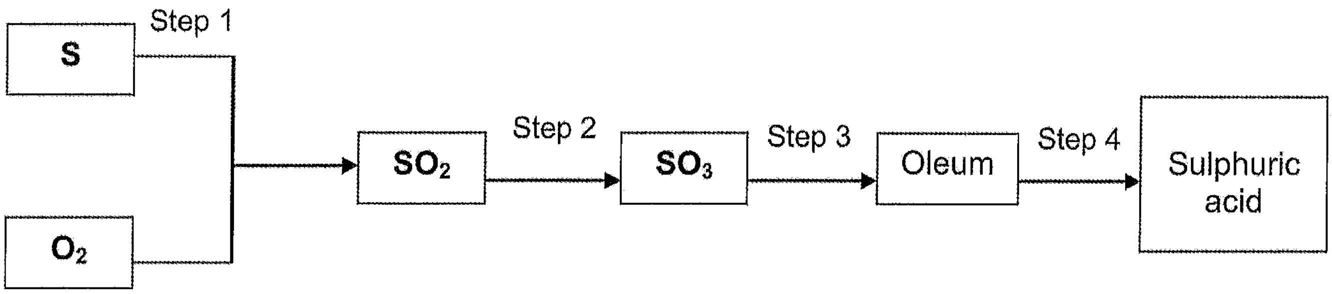
9.4.2 NAME or FORMULA of electrolyte **X** (1)

9.5 Give a reason why the concentration of electrolyte **X** remains constant during electroplating. (2)

**[9]**

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

10.1 Some of the steps in the industrial preparation of sulfuric acid are outlined below.




10.1.1 Write down a balanced equation for the reaction leading to the formation of $SO_3$ in Step 2. (2)

10.1.2 In which step is a catalyst used? (1)

10.1.3 Name the catalyst used. (1)

10.2 The rapidly increasing human population is resulting in an ever-increasing demand for food. To meet this demand, farmers apply fertiliser to the same cultivated land each year.

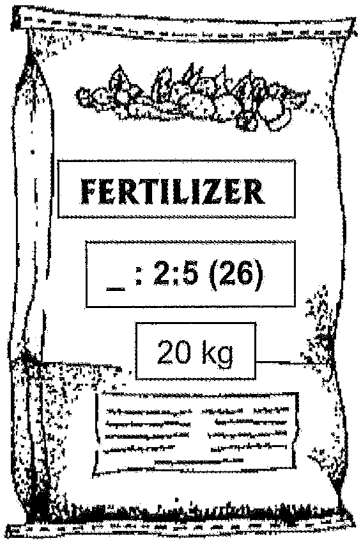
10.2.1 Explain why farmers have to apply fertiliser to the same land each year. (1)

10.2.2 Write down ONE negative impact that over-fertilisation can have on humans. (1)

10.2.3 What process occurs when excess fertilizers run into rivers? (1)

10.2.4 Write down the FORMULA of the fertiliser formed when sulfuric acid reacts with ammonia. (2)

10.3 Mr. Viljoen (a farmer) finds an old 20 kg bag of fertilizer. The label on the bag is only partially visible (see diagram below). He has the contents analysed and it is determined that the percentage of potassium in the bag is 13%.




10.3.1 What does the number (26) on the label represent? (1)

10.3.2 Determine the unknown component in the N.P.K ratio (4)
**[14]**

**TOTAL MARKS: 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<br>*Standaarddruk* | $p^{\theta}$ | $1,013 \times 10^{5}$ Pa |
| Molar gas volume at STP<br>*Molêre gasvolume by STD* | $V_m$ | $22,4\ dm^3 \cdot mol^{-1}$ |
| Standard temperature<br>*Standaardtemperatuur* | $T^{\theta}$ | 273 K |
| Charge on electron<br>*Lading op elektron* | e | $-1,6 \times 10^{-19}$ C |
| Avogadro's constant<br>*Avogadro-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 | |
| $E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$<br>or/*of*<br>$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$<br>or/*of*<br>$E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$ | |

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

**KEY/*SLEUTEL***

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

| 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2,1 1 H 1 | | | | | | | | | | | | | | | | | 2 He 4 |
| 1,0 3 Li 7 | 1,5 4 Be 9 | | | | | | | | | | | 2,0 5 B 11 | 2,5 6 C 12 | 3,0 7 N 14 | 3,5 8 O 16 | 4,0 9 F 19 | 10 Ne 20 |
| 0,9 11 Na 23 | 1,2 12 Mg 24 | | | | | | | | | | | 1,5 13 Aℓ 27 | 1,8 14 Si 28 | 2,1 15 P 31 | 2,5 16 S 32 | 3,0 17 Cℓ 35,5 | 18 Ar 40 |
| 0,8 19 K 39 | 1,0 20 Ca 40 | 1,3 21 Sc 45 | 1,5 22 Ti 48 | 1,6 23 V 51 | 1,6 24 Cr 52 | 1,5 25 Mn 55 | 1,8 26 Fe 56 | 1,8 27 Co 59 | 1,8 28 Ni 59 | 1,9 29 Cu 63,5 | 1,6 30 Zn 65 | 1,6 31 Ga 70 | 1,8 32 Ge 73 | 2,0 33 As 75 | 2,4 34 Se 79 | 2,8 35 Br 80 | 36 Kr 84 |
| 0,8 37 Rb 86 | 1,0 38 Sr 88 | 1,2 39 Y 89 | 1,4 40 Zr 91 | 41 Nb 92 | 1,8 42 Mo 96 | 1,9 43 Tc | 2,2 44 Ru 101 | 2,2 45 Rh 103 | 2,2 46 Pd 106 | 1,9 47 Ag 108 | 1,7 48 Cd 112 | 1,7 49 In 115 | 1,8 50 Sn 119 | 1,9 51 Sb 122 | 2,1 52 Te 128 | 2,5 53 I 127 | 54 Xe 131 |
| 0,7 55 Cs 133 | 0,9 56 Ba 137 | 57 La 139 | 1,6 72 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 | 1,8 81 Tℓ 204 | 1,8 82 Pb 207 | 1,9 83 Bi 209 | 2,0 84 Po | 2,5 85 At | 86 Rn |
| 0,7 87 Fr | 0,9 88 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 oxidising ability/*Toenemende oksiderende vermoë* (↑)

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

Increasing reducing ability/*Toenemende reduserende vermoë* (↓)

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↓)

Increasing reducing ability/*Toenemende reduserende vermoë* (↑)

| Half-reactions/*Halfreaksies* | | | $E^{\theta}$ (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 |

# Education

ducation
KwaZulu-Natal
REPUBLIC OF

Department of Education
SOUTHAFRICA

**PHYSICAL SCIENCES P2
(CHEMISTRY)
PREPARATORY**

**NATIONAL**

GRADE 12

**MARKS : 150**

**TIME : 3hours**

**This memorandum consists of 10 pages.**

**The marking guidelines as per 2014 Examination Guidelines, pages 34-37 must be applied when marking this Paper.**






**QUESTION 1**

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

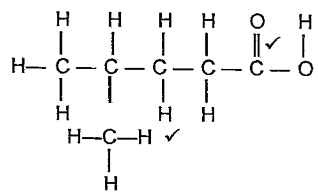
**QUESTION 2**

| | | |
|---|---|---|
| 2.1. | H ✓✓ | (2) |
| 2.2 | A ✓ | (1) |
| 2.3 | B ✓✓ | (2) |

2.2.1 chloroethene *accept* 1-chloroethene ✓✓ (2)

2.2.2 2-methylpentan-2-ol *accept* 2–methyl– 2-pentanol✓✓ (2)

2.3



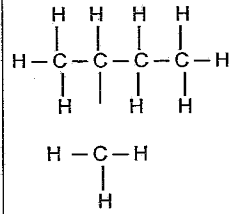
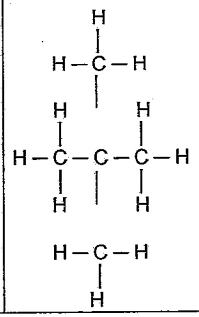

Functional group correct ✓ rest of structure correct ✓ (2) **[10]**

## QUESTION 3

3.1.1 Boiling does not involve breaking the chemical (intra molecular) bonds between atoms.✓
OR Boiling involves breaking the intermolecular forces between molecules.✓ (1)

3.1.2 Pentane has a longer chain of carbons than methane, therefore a greater surface area✓. Hence more sites for London force attraction✓ and stronger intermolecular forces. More energy is needed to break the stronger intermolecular forces.✓ (3)

3.1.3

| OPTION 1: 2-methylbutane ✓ (or methylbutane) | OPTION 2: 2,2-dimethylpropane ✓ (or dimethylpropane) |
|---|---|
|  ✓✓ |  ✓✓ |

(3)

3.2 The pressure exerted by a vapour at equilibrium with its liquid in a closed system. ✓✓ (2)

3.3.1 D ✓✓ (2)

3.3.2 A ✓✓ (2)

3.4 The carboxylic acid has the strongest intermolecular forces, ✓ because there are two sites for hydrogen bonding in each carboxylic acid molecule.✓ The stronger the intermolecular forces the lower the vapour pressure (at a given temperature). ✓ The graph indicates that D has the lowest vapour pressure. (3)

**[16]**





## QUESTION 4

4.1.1 methyl✓ ethanoate ✓ (2)

4.1.2
$M(C_3H_6O_2) = 74$

$n = \frac{m}{M}$ ✓

$= \frac{68,88}{74}$ ✓

$= 0,93$ mol

$M(CH_4O) = 32$
1 : 1 (alcohol : acid)
$m = 0,93 \times 32$ ✓

$= 29,78$ g

% purity : $\frac{29,78}{50} \times 100 = 59,57$ % ✓ (5)

4.2.1 A - hydration (or addition) ✓
C - substitution ✓
D - dehydration (or elimination) ✓
E - combustion ✓ (4)

4.2.2 (i) Dissolve $C_2H_5Cl$ in ethanol. ✓
(ii) Add concentrated NaOH solution. ✓
(iii) Heat the mixture. ✓ (3)

4.2.3 $H_2SO_4$ OR sulphuric acid ✓ (1)

4.2.4 Polythene OR Polyethene ✓ (1)

4.2.5 The chemical process in which longer chain hydrocarbon molecules are broken down to shorter molecules✓ at high temperatures (*and pressures*)✓. (2)

4.2.6 $C_4H_{10}$ ✓✓ (2)
**[20]**

## QUESTION 5

5.1 The amount of product formed/reactant used up✓ per unit time✓ (per second). (2)

5.2 concentration of HCl✓ (1)

5.3 Product $CO_2$ is an insoluble gas✓ and escapes from the beaker. ✓ (2)

5.4 Calcium carbonate is used up✓ and the reaction stops, no more $CO_2$ formed. ✓ (2)

5.5.1 graph B✓ (1)

5.5.2 graph D ✓ (1)

5.5.3 graph C✓ (1)

5.6 graph C✓.
Catalyst speeds up the rate of reaction✓, therefore gradient ✓of graph will be steepest for same initial mass. ✓ (4)

5.7 Remains the same. ✓ (1)
**[15]**





## QUESTION 6

6.1.1 Increases ✓ (1)

6.1.2 When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance. ✓ ✓ (2)

6.1.3 Increase in temperature increases $K_c$ ✓
Increase in $K_c$ indicates that the forward reaction has been favoured ✓,
Increase in temperature favours the endothermic reaction ✓,
Therefore the forward reaction is endothermic ✓. (4)

6.1.4 Add a catalyst ✓
Increase pressure OR decrease volume of container ✓ (2)

6.2

| | $A_2$ + | 2B → | 2AB |
|---|---|---|---|
| Initial (mol) | x | 2 | 0 ✓ |
| Used / formed | -0,2 | -0,4 | 0,4 ✓ (✓) |
| Equilibrium (mol) | x – 0,2 | 1,6 | 0,4 ✓ |
| [equilibrium] | x – 0,2 | 1,6 | 0,4 ✓ |

RATIO

Addition for **all** three

For conc. only ✓

| | $A_2$ + | 2B → | 2AB |
|---|---|---|---|
| Initial conc.(mol.dm$^{-3}$) | x | 2 | 0 ✓ |
| Used / formed | -0,2 | -0,4 | 0,4 ✓ (✓) |
| [equilibrium] | x – 0,2 | 1,6 | 0,4 ✓ |

RATIO

Addition for **all** three

$K_c = \frac{[AB]^2}{[A_2][B]^2}$ ✓

$= \frac{(0,4)^2}{(x-0,2)(1,6)^2}$ ✓

$= 0,5$

$\therefore 0,5\,[(x-0,2)(1,6)^2] = (0,4)^2$

$\therefore 1,28x - 0,256 = 0,16$

$\therefore x = 0,325$ mol ✓

Marking criteria:
- Initial mol/conc correctly indicated. ✓
- Mol/conc of AB produced = 0,4.✓
- Ratio applied correctly. ✓
- Equilibrium mol: ✓ initial – used / Initial + produced
  OR
  Equilibrium conc: ✓✓ initial – used / Initial + produced
- Equilibrium mol ÷ 1 = eq conc. ✓
- Correct Kc expression. ✓
- Substitution of eq conc to Kc expression. ✓
- Final answer. ✓

Wrong $K_c$ expression – (Max.: 4/8)
Wrong values on the table but used in the calculation (positive marking) - (Max.: 3/8) no mark for answer.

(8)
**[17]**





**QUESTION 7**

7.1.1

**Option 1:**

$pH = -\log[H_3O^+]$ ✓
$= 1$

$\therefore [H_3O^+] = 10^{-1} = 0{,}1$ ✓
$\therefore [HCl] = 0{,}1\ mol.dm^{-3}$ ✓

**Option 2:**

$pH = -\log[H_3O^+]$ ✓
$= 1$

$\therefore [HCl] = 0{,}1\ mol.dm^{-3}$ ✓✓

(3)

7.1.2 increase ✓ (1)

7.1.3 $Mg(OH)_2(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + 2H_2O(l)$ (3)

Reactants ✓ Products ✓ Balancing ✓

7.2 When an acid reacts with a base✓ to produce a salt and water. ✓ OR
Chemically equivalent quantities of acid and base are reacted. ✓✓ (2)

7.3

**Option 1:**

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ ✓

$n(NaOH) = c \times V$ ✓ $= 0{,}1 \times 0{,}012$✓ $= 0{,}0012$ mol

$n(H_2SO_4) = \frac{1}{2} \times n(NaOH)$ ✓ $= 0{,}0006$ mol

$V(H_2SO_4) = n/C = 0{,}0006 / 0{,}05 = 0{,}012\ dm^3$

$V(H_2SO_4)$ that reacts with $Ba(OH)_2 = 54 - 12$ ✓ $= 42\ cm^3$ (OR $0{,}054 - 0{,}012 = 0{,}042\ dm^3$)

$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$ ✓

$n(H_2SO_4)$ that reacts with $Ba(OH)_2 = c \times V = 0{,}05 \times (42 \times 10^{-3}\ mol) = 0{,}0021$ mol

$n(Ba(OH)_2) = 1 \times 0{,}0021 = 0{,}0021$ mol ✓

$[Ba(OH)_2] = n/v = 0{,}0021 \times 0{,}048$ ✓ $= 0{,}04375\ mol \cdot dm^{-3}$ ✓

7.3

| Option 2: | Option 3: |
|---|---|
| $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ ✓ | $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ ✓ |
| $n(NaOH) = c \times V$ ✓ $= 0,1 \times 0,012$ ✓ | $\frac{n_a}{n_b} = \frac{V_a \times c_a}{V_b \times c_b}$ ✓ |
| $= 0,0012$ mol | $\frac{1}{2}$ ✓ $= \frac{V_a \times 0,05}{0,1 \times 12}$ ✓ |
| $n(H_2SO_4) = ½ \times n(NaOH)$ ✓ | $V_a = 12\ cm^3$ |
| $= 0,0006$ mol | $V(H_2SO_4)_{with}\ Ba(OH)_2 \rightarrow 54 - 12$ ✓ $= 42\ cm^3$ |
| $n(H_2SO_4)_{tot} = c \times V$ | $Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$ ✓ |
| $= 0,05 \times (54 \times 10^{-3})$ | $\frac{n_a}{n_b} = \frac{V_a \times c_a}{V_b \times c_b}$ |
| $= 0,0027$ mol | $\frac{1}{1} = \frac{0,05 \times 42}{48 \times c_b}$ ✓ |
| $n(H_2SO_4)_{with}\ Ba(OH)_2$ | $[Ba(OH)_2] = 0,04375\ mol \cdot dm^{-3}$ ✓ |
| $= 0,0027 - 0,0006$ ✓ $= 0,0021$ mol | |
| $Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$ ✓ | |
| $n(Ba(OH)_2) = 1 \times 0,0021$ | |
| $= 0,0021$ mol | |
| $[Ba(OH)_2] = n / v = 0,0021 \times 0,048$ ✓ $=$ | |
| $0,04375\ mol \cdot dm^{-3}$ ✓ | |

(8)
**[17]**

**QUESTION 8**

8.1.1 Pt or the electrode where oxygen reacts or where peroxide is formed✓ (1)

8.1.2 $Cu \rightarrow Cu^{2+} + 2e^-$ ✓✓ (2)

| |
|---|
| $Cu \rightleftharpoons Cu^{2+} + 2e^-$ (1) |
| $Cu \leftarrow Cu^{2+} + 2e^-$ (0) |

8.1.3 $O_2 + 2H^+ + 2e^-$ ✓ $\rightarrow H_2O_2$ ✓ (2)

8.1.4 $E^\ominus_{cell} = E^\ominus_{cathode} - E^\ominus_{anode}$ ✓
$= 0,68$ ✓ $- 0,34$ ✓
$= 0,34\ V$ ✓ (4)

8.2 $2Ce + 3Pd^{2+}$ ✓ $\rightarrow 2Ce^{3+} + 3Pd$ ✓ (balance ✓) (3)
**[12]**





**QUESTION 9**

9.1 Electrical energy to chemical energy. ✓ (1)

9.2 Decrease in mass/ decrease in size/ gets used up/ errosion✓✓ (2)

9.3 Oxidation ✓ (1)

9.4

9.4.1 $Ag^+ + e^- \rightarrow Ag$ ✓✓ (2)

| |
|---|
| **Note:** Marking rule 3.3 |

9.4.2 Silver nitrate OR $AgNO_3$ ✓
**OR**
Silver ethanoate/silver acetate ✓
$CH_3COOAg$/ $AgC_2H_3O_2$/ $AgCH_3CO_2$
**OR**
$Ag^+$ ions (1)

9.5 Rate of oxidation is equal to the rate of reduction. ✓✓

**ACCEPT:** Reduction and oxidation take place simultaneously✓✓ (2)

**[9]**

**QUESTION 10**

10.1.1 $2SO_2 + O_2 \rightleftharpoons 2SO_3$ ✓✓ (ACCEPT: $2SO_2 + O_2 \rightarrow 2SO_3$ ✓✓) (2)

10.1.2 Step 2 ✓ (1)

10.1.3 Vanadium pentoxide ✓ (1)

10.2.1 Fertilisers must replenish nutrients used by growing of crops. ✓ (1)

10.2.2 **Any ONE:**

Excessive fertiliser seeps/washes into groundwater and contaminates Drinking Water **OR**
Excessive fertiliser run-off can lead to eutrophication which depletes aquatic life which serves as a food source **OR**
Excessive fertilisation can damage a crop which leads to a smaller harvest. ✓ (1)

10.2.3 Eutrophication ✓ (1)

10.2.4 $(NH_4)_2SO_4$ ✓✓ (2)

10.3.1 Total percentage of active fertiliser. *OR* Combined percentage of N, P and K.✓ (1)

10.3.2 **OPTION 1**

$13 = \frac{5}{x}$ ✓ x 26 ✓

x = 10 ✓

thus N = 3✓

N:P:K = 3: 2 : 5 (4)

**OPTION 2**

(N + P + K) in the bag = 26/100 x 20 = 5,2 kg

K in the bag = 13/100 x 5,2 = 2,6 kg

2,6/5,2 x 100 ✓ = 50% = 5 parts ✓

P = 2 parts = 20 % ✓

Therefore, N = 30% = 3 parts

Unknown component = 3. ✓ (4)

**[14]**