education

Department:
Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATION - 2005

PHYSICAL SCIENCE P2
CHEMISTRY

HIGHER GRADE

OCTOBER/NOVEMBER 2005

Marks: 200

2 Hours

This paper consists of 17 pages and data sheet of 4 pages.

GENERAL INSTRUCTIONS

1. Write your **examination number** (and **centre number** if applicable) in the appropriate spaces on the answer book.

2. Answer **ALL** the questions.

3. Non-programmable calculators may be used.

4. Appropriate mathematical instruments may be used.

5. Data sheets are attached for your use.

6. Marks may be forfeited if instructions are not followed.

QUESTION 1

INSTRUCTIONS

1 Answer this question on the specially printed **ANSWER SHEET.** *[NOTE: The answer sheet may be either a separate sheet provided as part of your question paper, or printed as part of the answer book.]* Write your **EXAMINATION NUMBER** (and **centre number** if applicable) in the appropriate spaces if a separate answer sheet is used**.**

2 Four possible answers, indicated by A, B, C and D, are supplied with each question. Each question has only ONE correct answer. Choose only that answer, which in your opinion, is the correct or best one and mark the appropriate block on the answer sheet with a cross.

3 Do not make any other marks on the answer sheet. Any calculations or writing that may be necessary when answering this question should be done in the answer book and must be deleted clearly by means of a diagonal line drawn across the page.

4 If more than one block is marked, no marks will be awarded for that answer.

PLACE THE COMPLETED ANSWER SHEET INSIDE THE FRONT COVER OF YOUR ANSWER BOOK, IF A SEPARATE ANSWER SHEET HAS BEEN USED.

EXAMPLE:

QUESTION: The SI unit of time is ...

A t.
B h.
C s.
D m.

ANSWER:

A	**B**	**C** (crossed)	**D**

QUESTION 1

1.1 Which one of the following industrial processes is used to prepare sulphuric acid?

A Haber process

B Contact process

C Ostwald process

D Electrolysis of brine (4)

1.2 Which one of the reactions below is the best explanation why nitrate compounds are used in the manufacture of fire works?

A $2NaNO_3 + H_2SO_4$ à $2HNO_3 + Na_2SO_4$

B $Cu + 4HNO_3$ à $Cu(NO_3)_2 + 2NO_2 + 2H_2O$

C $2KNO_3$ à $2KNO_2 + O_2$

D KNO_3 à $K^+ + NO_3^-$ (4)

1.3 Copper sulphate ($CuSO_4$) and iodine crystals (I_2) are added to a test tube containing water and tetrachloromethane. The test tube is thoroughly shaken. After allowing the test tube to stand for some time, the contents separate into two layers with the aqueous layer on top.

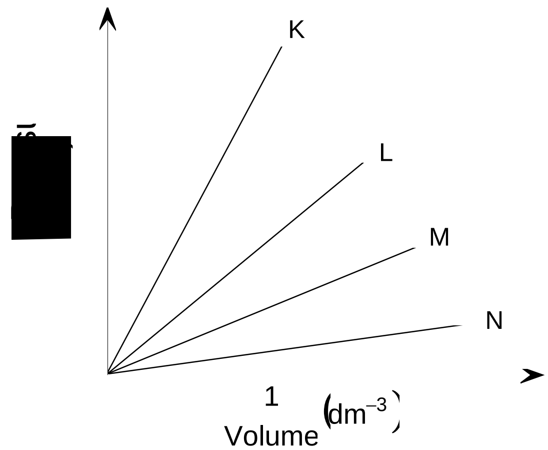
Which one of the sets of observations **AND** corresponding reasons in the table below is **CORRECT**?

	Observation	Reason
A	The bottom layer turns blue.	$CuSO_4$ dissolves in CCl_4.
B	The top layer turns blue.	$CuSO_4$ dissolves in H_2O.
C	The bottom layer turns purple.	I_2 is more dense than $CuSO_4$.
D	The top layer turns purple.	I_2 is highly soluble in H_2O.

(4)

1.4 Five grams (5 g) of each of the gases CO, NO_2, NH_3 and SO_2 are sealed in separate containers. The temperature of the gas is the same in each container and remains constant.

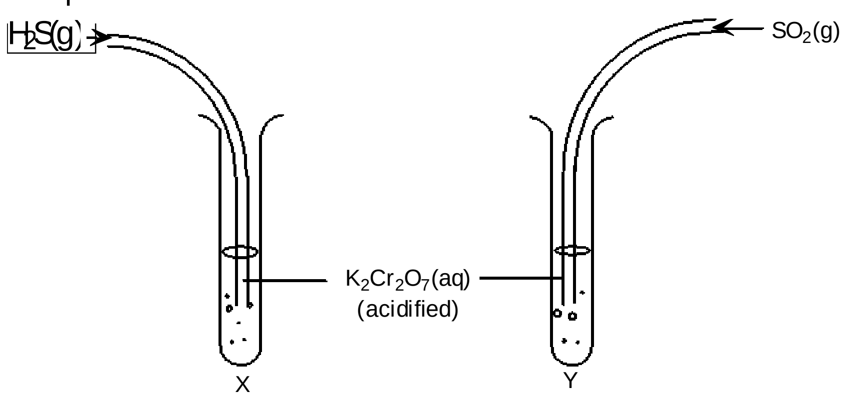
The graphs show the relationship between the pressure (p) and reciprocal of the volume ($\frac{1}{V}$) for each of the gases.



Which graph will represent the correct relationship between p and $\frac{1}{V}$ for NH_3 gas?

A K
B L
C M
D N (4)

1.5 Jason bubbles H_2S gas and SO_2 gas respectively through acidified solutions of $K_2Cr_2O_7$ in separate test tubes.



Which one of the following statements with regard to the above experiment is **CORRECT**?

A The solution in test tube X changes colour because the dichromate ions are oxidised to Cr^{3+} ions.

B In both test tubes the gases are oxidised to SO_4^{2-}.

C In one test tube a precipitate is formed.

D H_2S acts as a reducing agent while SO_2 acts as an oxidising agent. (4)

1.6 Each of the two reactions X and Y below is respectively in equilibrium in two separate sealed containers.

Reaction X: $2HI(g)$? $H_2(g) + I_2(g)$

Reaction Y: $CaCO_3(s)$? $CaO(s) + CO_2(g)$

The pressure in both containers is now increased by decreasing the volume.

How will the number of moles of the **products** in each reaction now change?

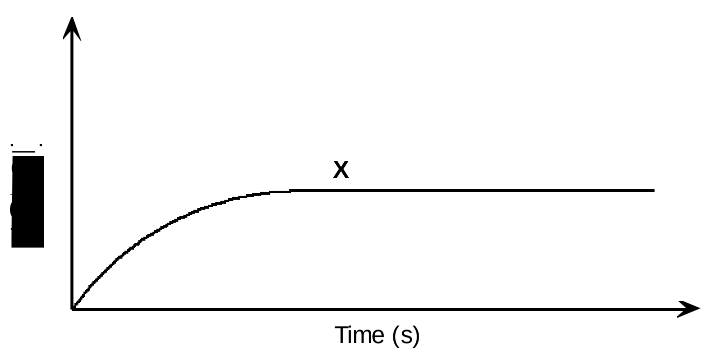
	Reaction X	Reaction Y
A	Increases	Decreases
B	Stays the same	Increases
C	Stays the same	Decreases
D	Increases	Stays the same

(4)

1.7 Methanol (CH_3OH) can be manufactured from carbon monoxide (CO) and hydrogen (H_2) as indicated by the following reversible reaction equation:

$CO(g) + 2H_2(g)$? $CH_3OH(g)$

The graph below shows how the concentration of methanol changes with time when $CO_2(g)$ and $H_2(g)$ are mixed in a closed container in the presence of a suitable catalyst.



Which one of the following best explains why the graph becomes horizontal at **X**?

A The forward reaction has stopped.

B There is no CO left to react with H_2.

C The rate of the forward reaction is equal to the rate of the reverse reaction.

D All the reacting gases have been converted to methanol. (4)

1.8 Solutions X and Y in the table below are mixed. One of the combinations of X and Y forms products that change blue litmus paper to red. This combination is:

	Solution X	Solution Y
A	$AgNO_3(aq)$	$ZnCl_2(aq)$
B	$Na_2CO_3(aq)$	$BaCl_2(aq)$
C	$Na_2SO_4(aq)$	$BaCl_2(aq)$
D	$H_2S(aq)$	$ZnCl_2(aq)$

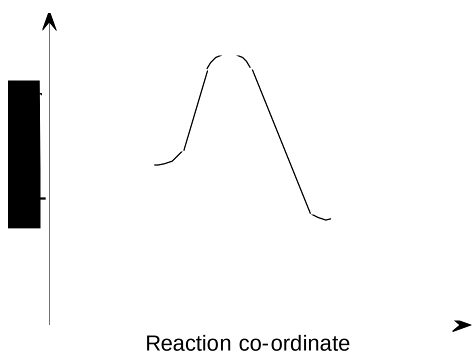
(4)

1.9 If base **X** is titrated against acid **Y**, the pH of the solution at the end point is 8. The base **X** and acid **Y** are respectively:

	X	Y
A	NaOH	CH_3COOH
B	Na_2CO_3	HCl
C	NaOH	H_2SO_4
D	Na_2CO_3	CH_3COOH

(4)

1.10 Consider the graph below.



Which of the following reactions can be represented by the graph?

Reaction X: $CaCO_3(s)$? $Ca^{2+}(aq)$ + $CO_3^{2-}(aq)$?H > 0

Reaction Y: The burning of methane gas.

A X only

B Y only

C Both X and Y

D Neither X nor Y

(4)

1.11 Four metals T, V, Y and Z exhibit the following properties:

§ Only T and Y react with 1 $mol.dm^{-3}$ HCl to produce H_2.

§ When Y is added to solutions of the ions of the other metals, metal precipitates of T, V and Z are respectively formed.

§ Metal Z reduces the ions of V to form metal V and ions of Z.

The four metals in order of **increasing** ability to act as reducing agent are …
(that is from weak to strong reducing agent)

A T, V, Y, Z

B Z, V, T, Y

C V, Z, T, Y

D Y, T, Z, V (4)

1.12 To protect a metal from oxidation it can be connected to another metal that then acts as an anode. Which one of the following metals would protect **tin** (Sn) from oxidation?

A Pb

B Ag

C Zn

D Au (4)

1.13 A standard electrochemical cell with an *emf* of 1,2 V was set up, using two of the half reactions with reduction potentials listed below.

P^{2+}	+	$2e^-$	?	P	- 0,3 V
Q^+	+	e^-	?	Q	- 0,9 V
R^+	+	e^-	?	R	- 1,5 V
S^{2+}	+	e^-	?	S	+ 1,5 V

The cell notation of this cell is …

A $R(s)/R^+(aq)//\ S^{2+}(aq)/S(s)$

B $S(s)/S^{2+}(aq)//P^{2+}(aq)/P(s)$

C $P(s)/P^{2+}(aq)//Q^+(aq)/Q(s)$

D $R(s)/R^+(aq)//P^{2+}(aq)/P(s)$ (4)

1.14 Which one of the following compounds has the formula $C_2H_4O_2$?

A Ethanol

B Methyl ethanoate

C Ethanoic acid

D Butanol (4)

1.15 Which one of the following gases will not decolourise a bromine solution through an addition reaction?

A Ethene

B Ethane

C Ethyne

D Chloroethene (4)

[60]

ANSWER QUESTIONS 2 – 9 IN YOUR ANSWER BOOK.

INSTRUCTIONS

1. Start each question on a new page in your answer book.
2. Leave one line between subsections, for example between QUESTIONS 2.1 and 2.2.
3. Give all formulae used and show your workings (this includes substitutions).
4. Number your answers in the same way that the questions are numbered.

QUESTION 2

2.1 Consider the boiling points of the following organic compounds with their respective molar masses.

NAME	CONDENSED STRUCTURE	MOLAR MASS ($g.mol^{-1}$)	BOILING POINT (°C)
Methanol	CH_3-OH	32	65
Ethanol	CH_3-CH_2-OH	46	78,5
Dimethyl ether	CH_3-O-CH_3	46	-23

2.1.1 What evidence is there in the table indicating that the intermolecular forces between molecules of methanol are weaker than between molecules of ethanol? (2)

2.1.2 Give a reason why the intermolecular forces between the molecules of methanol are weaker than those between molecules of ethanol. (2)

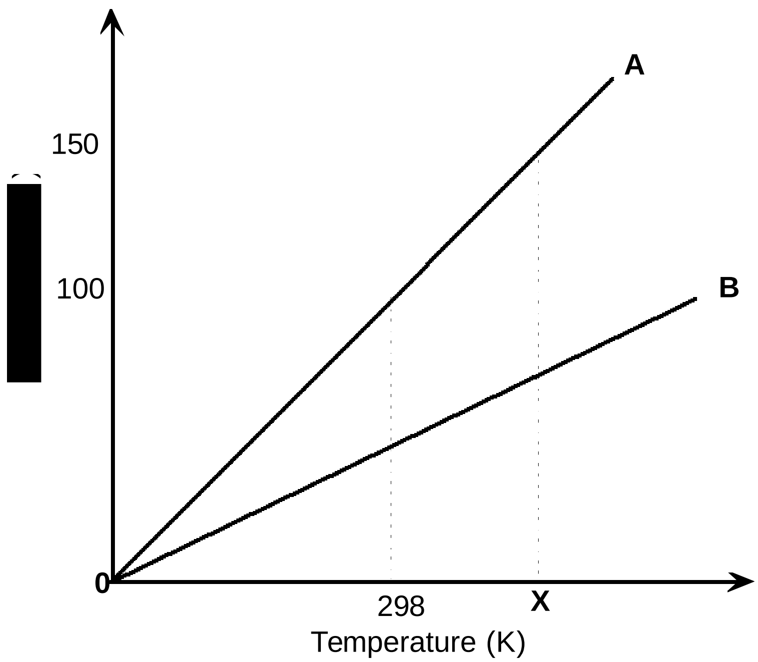
2.1.3 Give an explanation why the boiling point of dimethyl ether is lower than that of ethanol. (2)

2.1.4 Name the intermolecular forces in dimethyl ether. (2)

2.1.5 Considering the intermolecular forces, choose from **ethanol** or **dimethyl ether,** the one that is more soluble in water. (1)

2.2 Two learners, A and B, investigate the relationship between the temperature and pressure of an enclosed gas.

The learners used different samples of $SO_2(g)$ in two identical containers with a fixed volume of 1 dm^3. Their results (A and B) were plotted on the same set of axes, as indicated below.



2.2.1 Write down the mathematical relationship between p and T that can be deduced from the graph. (2)

2.2.2 Make use of the relationship in QUESTION 2.2.1 and determine the value of the temperature at **X** on the above graph. (4)

2.2.3 Determine the mass of $SO_2(g)$ used by learner A. (6)

2.2.4 Give a possible reason why the graph obtained by learner B has a smaller gradient than the graph obtained by learner A. (2)

[23]

QUESTION 3 (START ON A NEW PAGE)

Sulphur dioxide gas can be prepared in the laboratory by means of the reaction between sulphuric acid and a metal sulphite.

3.1 Write down a balanced equation for the preparation of sulphur dioxide by this method. (3)

The sulphur dioxide gas prepared is now passed over a filter paper dipped in a potassium permanganate solution.

3.2 What colour change will you observe when the gas is passed over the filter paper? (2)

3.3 Write the equation for the half reaction that will explain the colour change in QUESTION 3.2 above. (2)

3.4 Does the sulphur dioxide act as a reducing agent or an oxidising agent when it reacts with potassium permanganate? (1)

3.5 Give a reason for your answer to QUESTION 3.4. (2)

3.6 Write down the equation for the half reaction that sulphur dioxide undergoes in the reaction with potassium permanganate. (2)

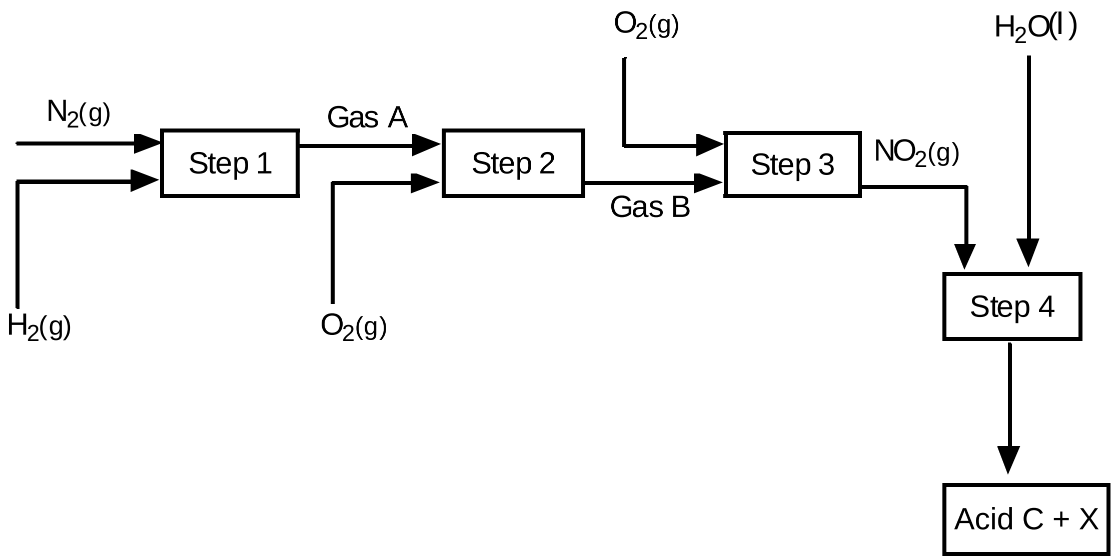
Acid rain is a result of the dissolving of atmospheric pollutants like $SO_2(g)$ in rain water.

3.7 Write down a balanced equation to show how SO_2 reacts with water. (3)

[15]

QUESTION 4 (START ON A NEW PAGE)

Consider the flow diagram that represents an important industrial process. This process consists of several steps.



4.1 Write down the balanced equation for the reaction taking place in Step 1 of the process. (3)

4.2 How is the N_2 required for this process obtained? (2)

4.3 Step 2 of the process is known as the 'catalytic oxidation of ammonia'. What is the meaning of 'catalytic oxidation'? (2)

4.4 Write down the **NAME** of gas B formed in this process. (2)

4.5 Write down a balanced equation for the formation of acid C. (3)

4.6 Both Step 1 and Step 3 are executed at high pressures. Give two reasons why high pressures are used for these two reactions. (4)

4.7 Does a redox reaction take place in each of the following steps? (Write only **YES** or **NO**.)

4.7.1 Step 1 (1)

4.7.2 Step 3 (1)

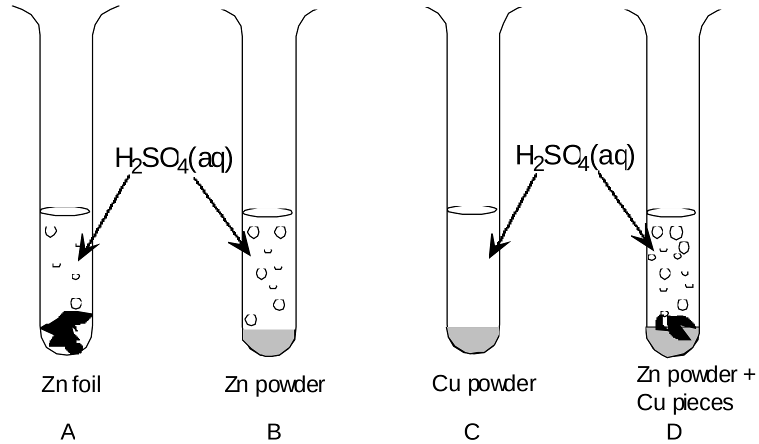
4.7.3 Step 4 (1)

[19]

QUESTION 5 (START ON A NEW PAGE)

5.1 A series of experiments is carried out to compare the reactions of zinc foil, zinc powder, copper powder and a mixture of zinc powder and copper pieces with dilute sulphuric acid of concentration 1 $mol.dm^{-3}$.

The pieces are of the same size.



If a reaction occurs, hydrogen gas is produced. The diagram shows the test tubes some time after the metals had been added to the acid.

5.1.1 In one of the test tubes no reaction is observed. Refer to the relative strength of oxidising agents and reducing agents to explain the reason for the observation. (4)

5.1.2 Give a reason for the difference between the rate of the reaction in test tube A and the rate of the reaction in test tube B. (2)

5.1.3 Give a reason for the difference between the rate of the reaction in test tube B and in the rate of the reaction in test tube D. (2)

5.2 Consider the following chemical equilibrium that exists in a closed container:

$$4C(s) + 5H_2(g) \ ? \ C_4H_{10}(g)$$

The equilibrium constant for this reaction at two different temperatures is given in the table below:

TEMPERATURE	EQUILIBRIUM CONSTANT
400 K	$1,58 \times 10^{-3}$
600 K	$1,58 \times 10^{-9}$

5.2.1 Is ΔH (heat of reaction) positive or negative for the above reaction? (1)

5.2.2 Explain how you arrived at the answer to QUESTION 5.2.1. (4)

5.2.3 The pressure in the container is increased by decreasing the volume. What effect will this have on the equilibrium constant?
(Write only **INCREASES, DECREASES** or **STAYS THE SAME**.) (2)

[15]

QUESTION 6 (START ON A NEW PAGE)

Exactly 12,0 mol SO_3(g) is sealed in an empty 2,0 dm^3 container. The following reaction reaches equilibrium at 700 K after 8 minutes.

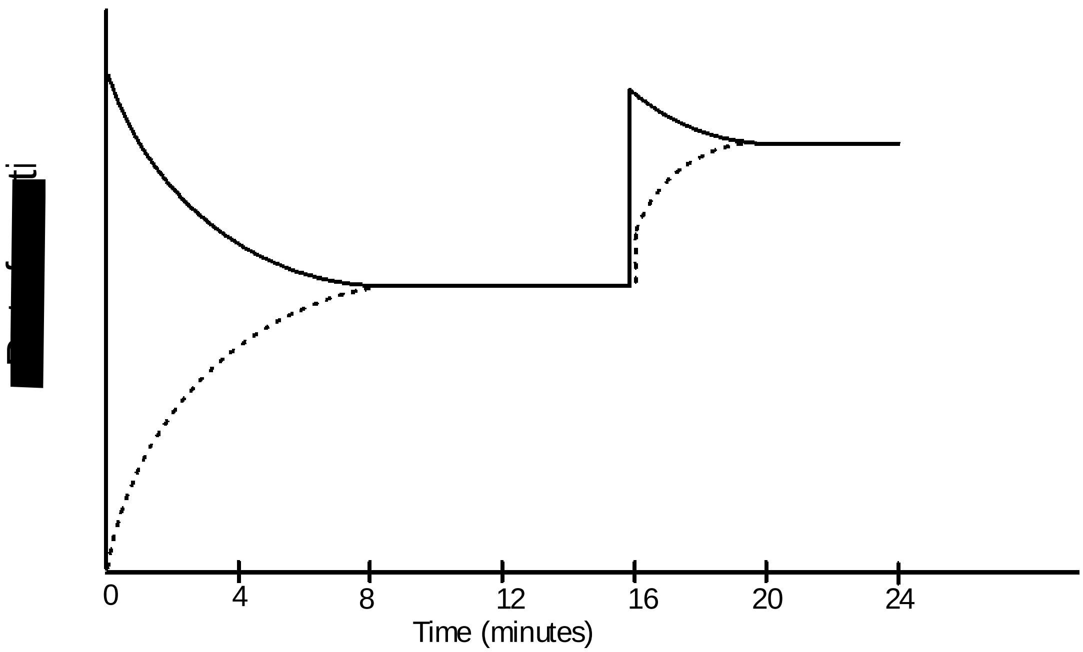
$$2SO_3(g) \ ? \ 2SO_2(g) + O_2(g)$$

6. If the reaction mixture contains 5,0 mol O_2(g) at equilibrium at 700 K, calculate
1 the:

6.1.1 Equilibrium concentration of each species. (3)

6.1.2 Value of the equilibrium constant (K_c) at this temperature. (3)

The temperature is increased to 800 K at the 16th minute.
The graph below shows the changes in the rate of the reaction over 24 minutes, from the time that the 12,0 mol of SO_3 was introduced into the container.



6. Write down the balanced equation for the reaction that is represented by the broken line. (2)

6. What is the reason for the decrease in the reaction rate represented by the solid
3 line between t = 0 minutes and t = 8 minutes? (2)

6. How does the value of K_c at the 24th minute compare to the value of K_c at the 12th minute? (State only **LARGER, SMALLER** or **THE SAME.**) (2)

6.5 What does the horizontal part of the graph between the 20th minute and the 24th minute indicate about the reaction? (2)

[14]

QUESTION 7 (START ON A NEW PAGE)

7.1 Write down:

7.1.1 The meaning of the term **diprotic** acid. (2)

7.1.2 The formula of a **diprotic** acid. (1)

7.2 Magnesium hydroxide ($Mg(OH)_2$) is often used as medicine to relieve an upset stomach. The pH of the HCl(aq) in a person's stomach is 1.

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

7.2.2 Will the pH in the stomach **INCREASE, DECREASE** or **STAY THE SAME** after taking in a dose of $Mg(OH)_2$? (2)

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

7.3 A textbook states that calcium sulphate ($CaSO_4$) is slightly soluble in water.

Two learners decided to test the dam water from a local municipality for calcium sulphate. They took a 0,5 dm^3 sample of the dam water and treated it with sodium carbonate solution to precipitate the calcium ions present according to the following equation:

$$CaSO_4(aq) + Na_2CO_3(aq) \text{ à } Na_2SO_4(aq) + CaCO_3(s)$$

The precipitate is then dissolved in 30 cm^3 of 0,1 $mol.dm^{-3}$ HCl solution which converts the precipitate to aqueous calcium chloride, water and carbon dioxide according to the following equation:

$$CaCO_3 + 2HCl \text{ à } CaCl_2 + CO_2 + H_2O$$

The HCl was in excess. They neutralised the excess HCl by adding 15,8 cm^3 of a
0,1 $mol.dm^{-3}$ NaOH solution. The equation for the reaction is:

$$HCl + NaOH \text{ à } NaCl + H_2O$$

Calculate the mass of calcium sulphate that was present in the sample of dam water. (10)

[21]

QUESTION 8 (START ON A NEW PAGE)

8.1 The following half reactions occur in a **rechargeable** nickel-cadmium cell.

$Cd(OH)_2(s) + 2e^-$? $Cd(s) + 2OH^-(aq)$ $E^o = -0,81$ V

$NiO(OH)(s) + H_2O(l) + e^-$? $Ni(OH)_2(s) + OH^-(aq)$ $E^o = +0.54$ V

8.1.1 Which electrode (Cd or NiO(OH)) is the anode? (1)

8.1.2 Write down the equation for the oxidation half reaction of this cell. (2)

8.1.3 Write down the balanced equation for the reaction that takes place when the cell is in operation. (3)

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

8.1.5 In which direction do electrons flow when the cell is being **recharged**? (Cd to NiO(OH) **OR** NiO(OH) to Cd) (1)

8.2 Chlorine gas can be prepared industrially by means of electrolysis of a brine solution (NaCl solution).

8.2.1 Make use of the table of Standard Reduction Potentials and write down the oxidation half reaction for this preparation. (2)

8.2.2 Considering the electrochemical properties of chlorine, give a reason why chlorine gas does not appear freely in nature, but must be prepared when needed. (2)

8.2.3 Is the industrial preparation of Cl_2 an example of an exothermic reaction? State **YES** or **NO**. (1)

[16]

QUESTION 9 (START ON A NEW PAGE)

9.1 Hexane is a component of petrol.

9.1.1 Name the homologous series of compounds to which hexane belongs. (2)

9.1.2 Write down the balanced equation for the reaction that takes place when hexane burns in excess oxygen. (3)

9.2 The following extract appeared in an evening newspaper:

Explosion rocks Winery
Huge damage occurred at the Rietboom Winery. A stainless steel tank in which sparkling wine is produced, exploded yesterday. The fermentation of the sugar in the grape juice apparently took place at such a high rate that the valves of the tank could not release the gaseous product of this reaction fast enough.

9.2.1 Write down the **FORMULA** of the product of fermentation that caused the tank to explode. (2)

9.2.2 Write down the **NAME** of the alcohol formed in the tank. (2)

9.2.3 When a bottle of white wine is left open for some time, it tastes sour. Name the chemical process that causes the wine to turn sour. (2)

9.2.4 Using structural formulae, write down the equation for the reaction that takes place between the alcohol in QUESTION 9.2.2 and ethanoic acid. (4)

9.2.5 Write down the systematic (IUPAC) name of the organic product formed in the reaction in QUESTION 9.2.4. (2)
[17]

TOTAL: 200

DEPARTMENT OF EDUCATION
DEPARTEMENT VAN ONDERWYS

SENIOR CERTIFICATE EXAMINATION
SENIORSERTIFIKAAT-EKSAMEN

DATA FOR PHYSICAL SCIENCE
PAPER 2 (CHEMISTRY)

GEGEWENS VIR NATUUR- EN SKEIKUNDE
VRAESTEL 2 (CHEMIE)

TABEL 1: FISIESE KONSTANTE

TABLE 1: PHYSICAL CONSTANTS

Avogadro-konstante Avogadro's constant	N_A of/or L	$6{,}02 \times 10^{23}$ mol^{-1}
Molêre gaskonstante Molar gas constant	R	8,31 J.K^{-1}.mol^{-1}
Standaarddruk Standard pressure	p^θ	$1{,}013 \times 10^5$ Pa
Molêre gasvolume by STD Molar gas volume at STP	V_m	22,4 dm^3.mol^{-1}
Standaardtemperatuur Standard temperature	T^θ	273 K

TABEL 2: FORMULES

TABLE 2: FORMULAE

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$	$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$
$pV = nRT$	$K_w = [H^+][OH^-] = 10^{-14}$ by/at 298 K
$n = \frac{m}{M}$	$pH = -\log[H^+]$
$c = \frac{n}{V}$	$E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$
$c = \frac{m}{MV}$	$E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$
	$E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$
	$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$

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

KEY/SLEUTEL

Atoomgetal / Atomic number	29
Simbool / Symbol	Cu
Relatiewe atoommassa (benaderd) / Relative atomic mass (approximately)	63,5
Elektronegatiwiteit / Electronegativity	1,9

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

Halfreaksie / Half-reaction	E° /volt
$F_2 + 2e^- \;?\; 2F^-$	+2,87
$H_2O_2 + 2H^+ + 2e^- \;?\; 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \;?\; Mn^{2+} + 4H_2O$	+1,51
$Au^{3+} + 3e^- \;?\; Au$	+1,42
$Cl_2 + 2e^- \;?\; 2Cl^-$	+1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \;?\; 2Cr^{3+} + 7H_2O$	+1,33
$O_2 + 4H^+ + 4e^- \;?\; 2\,H_2O$	+1,23
$MnO_2 + 4H^+ + 2e^- \;?\; Mn^{2+} + 2H_2O$	+1,21
$Pt^{2+} + 2e^- \;?\; Pt$	+1,20
$Br_2 + 2e^- \;?\; 2Br^-$	+1,09
$NO_3^- + 4H^+ + 3e^- \;?\; NO + 2H_2O$	+0,96
$Ag^+ + e^- \;?\; Ag$	+0,80
$NO_3^- + 2H^+ + e^- \;?\; NO_2 + H_2O$	+0,80
$Hg^{2+} + 2e^- \;?\; Hg$	+0,79
$Fe^{3+} + e^- \;?\; Fe^{2+}$	+0,77
$O_2 + 2H^+ + 2e^- \;?\; H_2O_2$	+0,68
$I_2 + 2e^- \;?\; 2I^-$	+0,54
$SO_2 + 4H^+ + 4e^- \;?\; S + 2H_2O$	+0,45
$2H_2O + O_2 + 4e^- \;?\; 4OH^-$	+0,40
$Cu^{2+} + 2e^- \;?\; Cu$	+0,34
$SO_4^{2-} + 4H^+ + 2e^- \;?\; SO_2 + 2H_2O$	+0,17
$Cu^{2+} + e^- \;?\; Cu^+$	+0,16
$Sn^{4+} + 2e^- \;?\; Sn^{2+}$	+0,15
$S + 2H^+ + 2e^- \;?\; H_2S$	+0,14
$2H^+ + 2e^- \;?\; H_2$	**0,00**
$Fe^{3+} + 3e^- \;?\; Fe$	-0,04
$Pb^{2+} + 2e^- \;?\; Pb$	-0,13
$Sn^{2+} + 2e^- \;?\; Sn$	-0,14
$Ni^{2+} + 2e^- \;?\; Ni$	-0,25
$Co^{2+} + 2e^- \;?\; Co$	-0,28
$Cd^{2+} + 2e^- \;?\; Cd$	-0,40
$Fe^{2+} + 2e^- \;?\; Fe$	-0,44
$Cr^{3+} + 3e^- \;?\; Cr$	-0,74
$Zn^{2+} + 2e^- \;?\; Zn$	-0,76
$2H_2O + 2e^- \;?\; H_2 + 2OH^-$	-0,83
$Mn^{2+} + 2e^- \;?\; Mn$	-1,18
$Al^{3+} + 3e^- \;?\; Al$	-1,66
$Mg^{2+} + 2e^- \;?\; Mg$	-2,37
$Na^+ + e^- \;?\; Na$	-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

Ir creasing reducing ability / Toenemende reduseervermoë (↓)

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

Increasing oxidising ability / Toenemende oksideervermoë ↓

Increasing reducing ability / Toenemende reduseervermoë ↑

Half-reaction / Halfreaksie	E° /volt
$Li^+ + e^-$? 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	-2,37
$Al^{3+} + 3e^-$? Al	-1,66
$Mn^{2+} + 2e^-$? Mn	-1,18
$2H_2O + 2e^-$? $H_2 + 2OH^-$	-0,83
$Zn^{2+} + 2e^-$? Zn	-0,76
$Cr^{3+} + 3e^-$? Cr	-0,74
$Fe^{2+} + 2e^-$? Fe	-0,44
$Cd^{2+} + 2e^-$? Cd	-0,40
$Co^{2+} + 2e^-$? Co	-0,28
$Ni^{2+} + 2e^-$? Ni	-0,25
$Sn^{2+} + 2e^-$? Sn	-0,14
$Pb^{2+} + 2e^-$? Pb	-0,13
$Fe^{3+} + 3e^-$? Fe	-0,04
$2H^+ + 2e^-$? H_2	**0,00**
$S + 2H^+ + 2e^-$? H_2S	+0,14
$Sn^{4+} + 2e^-$? Sn^{2+}	+0,15
$Cu^{2+} + e^-$? Cu^+	+0,16
$SO_4^{2-} + 4H^+ + 2e^-$? $SO_2 + 2H_2O$	+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
$I_2 + 2e^-$? $2I^-$	+0,54
$O_2 + 2H^+ + 2e^-$? H_2O_2	+0,68
$Fe^{3+} + e^-$? Fe^{2+}	+0,77
$Hg^{2+} + 2e^-$? Hg	+0,79
$NO_3^- + 2H^+ + e^-$? $NO_2 + H_2O$	+0,80
$Ag^+ + e^-$? Ag	+0,80
$NO_3^- + 4H^+ + 3e^-$? $NO + 2H_2O$	+0,96
$Br_2 + 2e^-$? $2Br^-$	+1,09
$Pt^{2+} + 2e^-$? Pt	+1,20
$MnO_2 + 4H^+ + 2e^-$? $Mn^{2+} + 2H_2O$	+1,21
$O_2 + 4H^+ + 4e^-$? $2H_2O$	+1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$? $2Cr^{3+} + 7H_2O$	+1,33
$Cl_2 + 2e^-$? $2Cl^-$	+1,36
$Au^{3+} + 3e^-$? Au	+1,42
$MnO_4^- + 8H^+ + 5e^-$? $Mn^{2+} + 4H_2O$	+1,51
$H_2O_2 + 2H^+ + 2e^-$? $2H_2O$	+1,77
$F_2 + 2e^-$? $2F^-$	+2,87

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1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D
1.11	A	B	C	D
1.12	A	B	C	D
1.13	A	B	C	D
1.14	A	B	C	D
1.15	A	B	C	D

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