education

Department:
Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATION - 2007

PHYSICAL SCIENCE P2
CHEMISTRY

HIGHER GRADE

FEBRUARY/MARCH 2007

304-1/2

PHYSICAL SCIENCE HG: Paper 2

Marks: 200

Time: 2 hours

304 1 2E HG

This paper consists of 15 pages and a data sheet of 4 pages.

X05

GAUTENG

Please turn over

GENERAL INSTRUCTIONS

1. Answer ALL questions.
2. Non-programmable calculators may be used.
3. Appropriate mathematical instruments may be used.
4. A data sheet is provided for your use.

QUESTION 1

INSTRUCTIONS

1. Answer this question on the answer sheet on the inside cover of your answer book.
2. In the case of a wrong answer, erase the pencil marks completely.
3. Do not make any other marks on your answer sheet. Any calculations or writing that may be necessary when answering this question should be done in the answer book and must be clearly deleted by means of a diagonal line drawn across the page.
4. Four possible answers, indicated by A, B, C and D, are supplied with each question. Choose only that answer, which in your opinion, is the correct or best one and mark the appropriate block on your answer sheet with a cross.
5. Each question has only one correct answer.
6. If more than one block is marked, no marks will be awarded for that answer.

EXAMPLE

QUESTION: The symbol for the unit of time is ...

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

ANSWER:

A	B	~~C~~	D

1.1 Ammonia gas can be liquefied under high pressures. This provides evidence for the fact that ...

A its molecules are moving.

B its molecules occupy no volume.

C there exist forces between its molecules.

D its molecules have open spaces between them. (4)

1.2 Substances X, Y and Z have the following properties:

X: Has an extremely high melting point and does not conduct electricity.

Y: Has a low melting point and does not conduct electricity.

Z: Has a high melting point and conducts electricity only in the molten state.

X, Y and Z could be:

	X	Y	Z
A	Graphite	Sodium chloride	Iodine
B	Diamond	Graphite	Iodine
C	Sodium chloride	Diamond	Iodine
D	Diamond	Iodine	Sodium chloride

(4)

1.3 Consider equal masses of each of the four different gases given below. The gases are at the same temperature and pressure. The gas that will occupy the **smallest** volume is ...

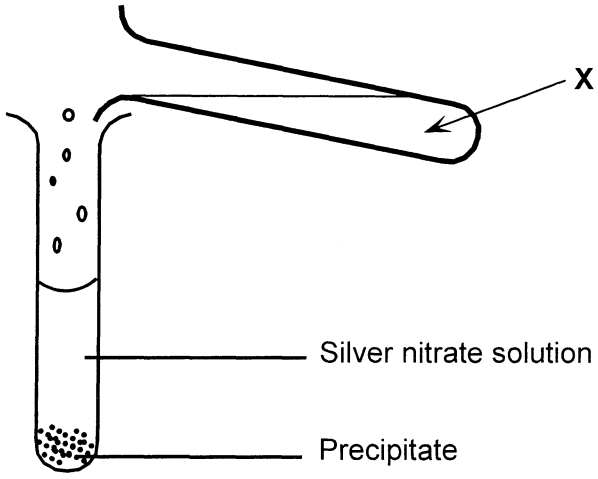
A helium.

B chlorine.

C hydrogen.

D sulphur dioxide. (4)

1.4 The solution in test tube X has a pH less than 4. When it is added to a dilute aqueous solution of silver nitrate, a precipitate forms. The contents of test tube X are probably a solution of …



A NH_3

B $HC\ell$

C HNO_3

D Na_2CO_3 (4)

1.5 Consider the reaction below:

$$2Fe^{3+} + 2H_2O + SO_2 \rightarrow 2Fe^{2+} + SO_4^{2-} + 4H^+$$

In this reaction the oxidation half reaction is…

A $2Fe^{2+} \rightarrow 2Fe^{3+} + 2e^-$

B $SO_2 + 2H_2O \rightarrow SO_4^{2-} + 4H^+ + 2e^-$

C $Fe^{3+} + e^- \rightarrow Fe^{2+}$

D $SO_4^{2-} + 4H^+ + 2e^- \rightarrow SO_2 + 2H_2O$ (4)

1.6 In which one of the following reactions is nitric acid a product?

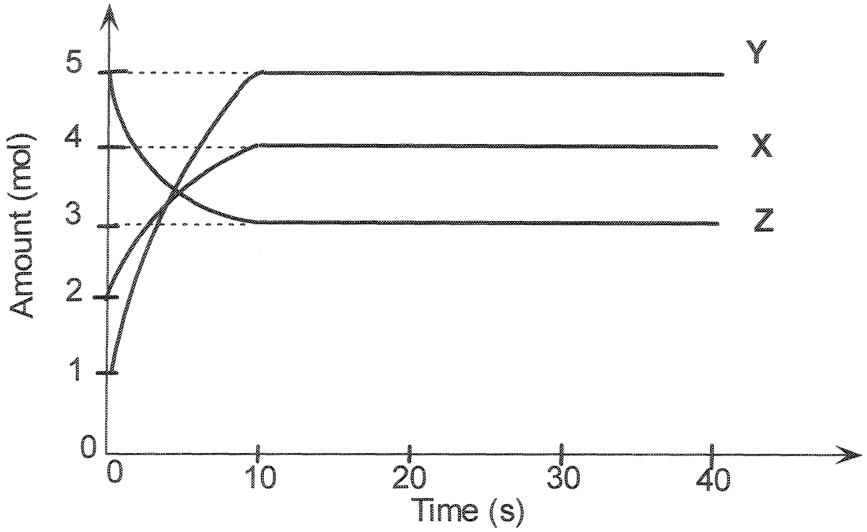
A Ammonium chloride is heated.

B Catalytic oxidation of ammonia.

C Calcium hydroxide reacts with ammonium chloride.

D The final reaction that takes place in the Ostwald process. (4)

1.7 The following graph shows the relationship between the amount of substance (in moles) versus time in a chemical reaction between substances X, Y and Z.



The equation for the reaction can be represented as follows :

A $3Z \rightleftharpoons 4X + 5Y$

B $5Z \rightleftharpoons 2X + Y$

C $2Z \rightleftharpoons X + 2Y$

D $Z \rightleftharpoons X + 2Y$ (4)

1.8 Which one of the following equations best explains why an **iron** nail should not be used to mount a **copper** plate on a wall?

A $Fe^{2+} + Cu \rightarrow Fe + Cu^{2+}$

B $Fe + Cu^{2+} \rightarrow Fe^{2+} + Cu$

C $Fe^{3+} + Cu \rightarrow Fe + Cu^{2+}$

D $Fe + Cu \rightarrow Fe^{2+} + Cu^{2+}$ (4)

1.9 Consider the following equation of the equilibrium reaction taking place in a closed container:

$$N_2H_4(g) \rightleftharpoons N_2(g) + 2H_2(g) \qquad \Delta H = -95,4 \text{ kJ mol}^{-1}$$

According to **Le Chatelier's principle**, the conditions of temperature and pressure under which the **highest yield** of nitrogen (N_2) will be obtained are:

	Temperature	Pressure
A	Low	High
B	High	High
C	High	Low
D	Low	Low

(4)

1.10 When sodium carbonate (Na_2CO_3) dissolves in water, the pH of the solution is 9,82. Which one of the following equations offers the best explanation for this?

A $2H_2O \rightleftharpoons H_3O^+ + OH^-$

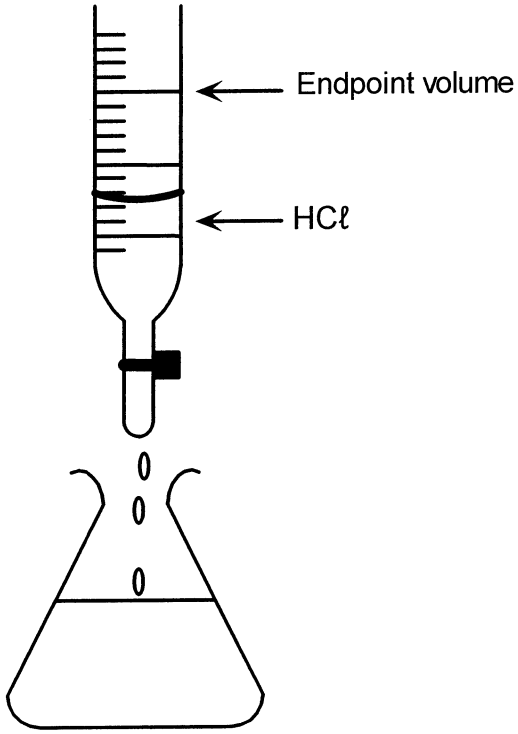
B $Na_2CO_3 \rightleftharpoons 2Na^+ + CO_3^{2-}$

C $CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$

D $H_3O^+ + OH^- \rightleftharpoons H_2O$

(4)

1.11 In a titration involving HCℓ and NaOH, as shown in the sketch below, a learner accidentally exceeds the endpoint.



Which one of the following is correct for the solution now in the beaker?

A $[H^+] < [OH^-]$ and pH < 7

B $[H^+] > [OH^-]$ and pH < 7

C $[H^+] < [OH^-]$ and pH > 7

D $[H^+] > [OH^-]$ and pH > 7

(4)

1.12 Reactions S and K below show two different chemical properties of concentrated sulphuric acid.

S: $Cu + 2H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2$
K: $CuSO_4.5H_2O + H_2SO_4 \rightarrow CuSO_4 + H_2SO_4 + 5H_2O$

Which combination of properties of H_2SO_4 is correct?

	Reaction S	Reaction K
A	Oxidising agent	Proton donor
B	Proton donor	Oxidising agent
C	Oxidising agent	Dehydrating agent
D	Dehydrating agent	Proton donor

(4)

1.13 An electrochemical cell is set up using the following half-reactions:

$Ni^{2+} + 2e^- \rightleftharpoons Ni$ $E^\circ = -0.25$ V

$Fe^{2+} + 2e^- \rightleftharpoons Fe$ $E^\circ = -0,44$ V

The reducing agent in the cell reaction is ...

A Fe
B Fe^{2+}
C Ni^{2+}
D Ni

(4)

1.14 Consider a solution of the following organic compound:

$C_2H_4O_2$

Which one of the following statements concerning this compound is TRUE?

A It is an alcohol.
B It is an ester.
C It is used in welding.
D It can turn red litmus blue.

(4)

1.15 Ethyne is used in the welding of metals because ...

A it is unsaturated.
B it reacts with metals.
C it produces O_2 and H_2O when it burns.
D its reaction with oxygen is highly exothermic.

(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 open between sub-sections, 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 (START ON A NEW PAGE)

2.1 Consider samples of the following gases at room temperature:

Ammonia
Hydrogen chloride
Helium

2.1.1 Write down the names of the intermolecular forces found between:

2.1.1.1 Ammonia particles (1)

2.1.1.2 Hydrogen chloride particles (1)

2.1.1.3 Helium particles (1)

2.1.2 If the temperatures of the gases are decreased considerably, which one of the three gases will liquefy first? (1)

2.1.3 Write down a reason for the answer in QUESTION 2.1.2. (2)

2.1.4 Which one of the three gases will show behaviour that corresponds closest to that of an ideal gas at most temperature and pressure values? (1)

2.1.5 Write down a reason for the answer in QUESTION 2.1.4. (2)

2.2 A 10 ℓ steel vessel that holds a sample of oxygen gas at 25 °C and 100 kPa, develops a leak. 6,00 g of the gas escapes before the leak is repaired. Calculate the pressure of the oxygen in the vessel after the leak is repaired, if the temperature remains at 25 °C. (11)

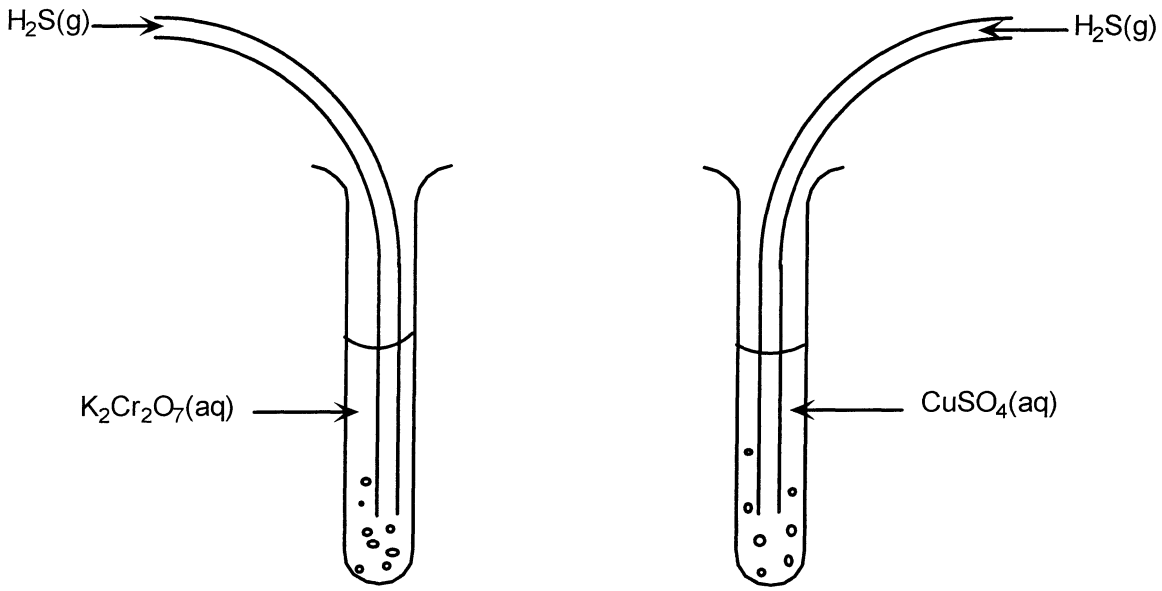
[20]

QUESTION 3 (START ON A NEW PAGE)

Hydrogen sulphide gas is prepared in the laboratory.

3.1 Write down the balanced equation for the laboratory preparation of hydrogen sulphide. (3)

The gas is now bubbled through two separate test tubes. Test tube A contains an acidified solution of potassium dichromate while Test tube B contains a solution of copper(II) sulphate as indicated in the diagram below. In both test tubes a colour change is observed and a precipitate forms.



3.2 Refer to the ions present in the test tubes and explain why the colour changes from orange to green when the gas is bubbled through the solution in one of the test tubes? (2)

3.3 Make use of the Table of Standard Reduction Potentials and write a half reaction that will support your answer in QUESTION 3.2. (2)

In Test tube A the hydrogen sulphide is the reducing agent.

3.4 Explain why hydrogen sulphide can act as the reducing agent in this reaction. (2)

3.5 What is the difference between the type of reaction taking place in Test tube A and Test tube B? (2)

3.6 Write a balanced equation for the reaction taking place in test Tube B. (3)

3.7 Apart from the distinct odour, how will you identify hydrogen sulphide? (2)
[16]

QUESTION 4 (START ON A NEW PAGE)

4.1 Ammonia is prepared in the laboratory by making use of $Ca(OH)_2$.

4.1.1 Write a balanced equation for the preparation of ammonia. (3)

4.1.2 How is the ammonia collected when it forms?
Write only UPWARD DISPLACEMENT OF AIR, DOWNWARD DISPLACEMENT OF AIR or DOWNWARD DISPLACEMENT OF WATER. (2)

4.1.3 Give a reason for the answer in QUESTION 4.1.2. (2)

In a school laboratory the stopper of the bottle containing HCℓ is covered with a white crystalline substance.

4.1.4 Write a balanced equation that will explain the formation of the white crystalline substance. (3)

4.2 When concentrated hydrochloric acid is added to potassium permanganate crystals, a redox reaction takes place and a gas is liberated.

4.2.1 Write down the name of the gas formed during this reaction. (2)

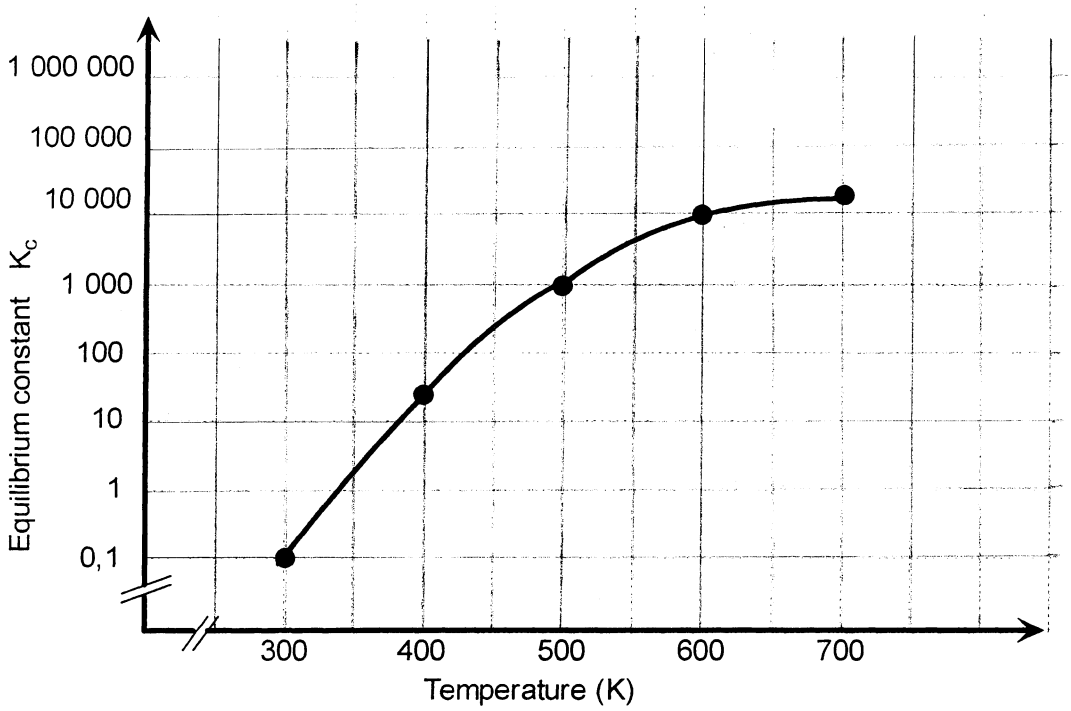
4.2.2 Is the permanganate oxidised or reduced during this reaction?
Write only OXIDISED or REDUCED. (1)

4.2.3 Making use of the Table of Standard Reduction Potentials write down a half reaction that will explain the answer in QUESTION 4.2.2. (2)
[15]

QUESTION 5 (START ON A NEW PAGE)

5.1 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:

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



5.1.1 What effect does an increase in temperature have on the value of K_c? (1)

5.1.2 Which reaction was favoured due to an increase in temperature? Write only FORWARD or REVERSE. (1)

5.1.3 Using Le Chatelier's principle, explain whether the forward reaction is exothermic or endothermic. (4)

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

5.2 The equilibrium constant K_c is 360 at 298 K for the reaction:

$$AgC\ell(s) + Br^-(aq) \rightleftharpoons AgBr(s) + C\ell^-(aq)$$

If a 0,2 mol.dm^{-3} solution of $Br^-(aq)$ is added to solid $AgC\ell$, what will the equilibrium concentrations of $Br^-(aq)$ and $C\ell^-(aq)$ at 298 K be? Your calculation must be accurate to three decimal places. (8)

5.3 A saturated solution of sodium chloride is placed in a small beaker. Concentrated hydrochloric acid is now slowly added to the solution.

5.3.1 Write down the meaning of the term saturated solution. (2)

5.3.2 Write down a balanced equation that will represent this saturated solution. (3)

5.3.3 Use the equation in QUESTION 5.3.2 to state what will be observed in the beaker when the concentrated hydrochloric acid is added to the saturated solution. (1)

5.3.4 Give an explanation for the observation in QUESTION 5.3.3. (3)

5.3.5 A few drops of silver nitrate are now added to the solution in the beaker. Write down an equation for the reaction that takes place. (3)

[28]

QUESTION 6 (START ON A NEW PAGE)

A learner determined the pH of a number of solutions at 25 °C. She obtained the following results:

Solution	Battery acid	Orange juice	Bicarbonate of soda
pH	1	4,2	12

6.1 Which solution contains the highest concentration of hydrogen ions? (2)

6.2 Calculate the concentration of hydroxide ions in orange juice. (5)

6.3 How will the pH of battery acid change when ...
(Only write INCREASES, DECREASES or STAYS THE SAME.)

6.3.1 distilled water is added to it? (2)

6.3.2 some of the bicarbonate of soda solution is added to it? (2)
[11]

QUESTION 7 (START ON A NEW PAGE)

As a class project, learners were asked to determine the amount of inert (un-reactive) impurities in a contaminated sample of anhydrous oxalic acid ($H_2C_2O_4$).

One group of learners prepared a standard solution of sodium hydroxide (NaOH) by diluting 50 cm^3 of a 1,63 $mol.dm^{-3}$ solution in a 1 dm^3 volumetric flask.

They then prepared a solution of the contaminated oxalic acid by dissolving 0,25 g of the oxalic acid in 75 cm^3 of water. The acid solution was then titrated against the NaOH solution. The titration required 40 cm^3 of the NaOH solution to reach end point.

The equation for this reaction is:

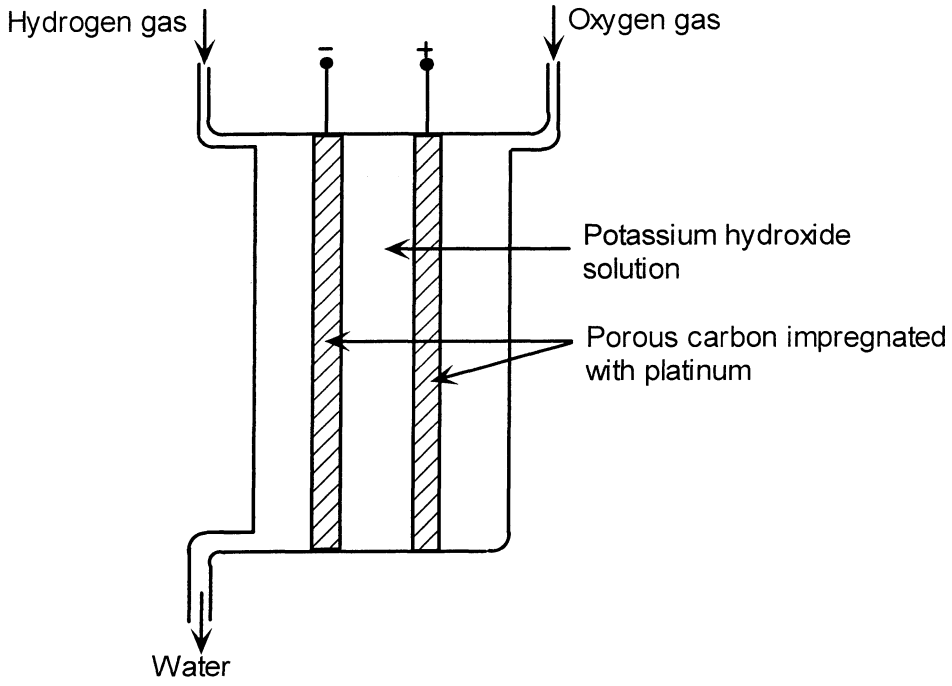
$$2NaOH + H_2C_2O_4 \rightarrow Na_2C_2O_4 + 2H_2O$$

7.1 What is meant by end point? (2)

7.2 Use the information that the learners obtained and calculate the percentage purity of the oxalic acid sample. (10)
[12]

QUESTION 8 (START ON A NEW PAGE)

8.1 An oxygen-hydrogen fuel cell is used to provide electricity for a manned space vehicle. A simplified diagram of a fuel cell is shown below. The hydrogen and oxygen gases are passed over platinum electrodes immersed in potassium hydroxide. The water that is produced when the cell is in operation, is used for drinking and washing by the astronauts.



In the fuel cell, the hydrogen gas reacts according to the equation:

$$H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$$

8.1.1 Is the hydrogen half reaction occurring at the anode or the cathode? Give a reason for your answer. (3)

8.1.2 Write down an equation for the half-reaction that the oxygen undergoes. (2)

8.1.3 Write down a balanced equation for the overall reaction in the fuel cell. (2)

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

8.1.5 In the fuel cell, the mass of the anode remains constant whereas in the Zn-Cu cell, the mass of the anode decreases. Write down a reason for this observation. (2)

8.2 The following chemicals are available in the school laboratory:

$SO_2(g)$ $H_2S(g)$ concentrated $HNO_3(\ell)$

8.2.1 Select one of the chemicals that could be used to convert Fe^{2+} to Fe^{3+}. (2)

8.2.2 Refer to the relative strengths of oxidising and reducing agents and give a reason for the answer in QUESTION 8.2.1. (2)

8.2.3 Write down a balanced ionic equation for the reaction between the chemical mentioned in QUESTION 8.2.1 and Fe^{2+}. Make use of the Table of Standard Reduction Potentials. (3)

[20]

QUESTION 9 (START ON A NEW PAGE)

9.1 Hydrocarbons are obtained from crude oil through fractional distillation.

9.1.1 Which physical property is used to separate the various hydrocarbons from crude oil? (2)

9.1.2 Which of the hydrocarbons, ethane or butane, will be removed first during distillation? (1)

9.1.3 Give a reason for the answer in QUESTION 9.1.2. (2)

9.2 Organic compounds are widely used in homes and industries. Consider the following list of organic compounds represented by the letters A to F:

A.	C_2H_2	B.	C_4H_{10}	C.	$CHC\ell_3$
D.	$C_2C\ell_4$	E.	CH_3COOH	F.	HCOOH

From the list choose one compound that is used: (Write down the letter of the correct answer only)

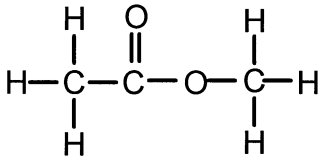
9.2.1 In dry cleaning (1)

9.2.2 As an anaesthetic (1)

9.2.3 As a household acid (1)

9.2.4 In gas lighters (1)

9.3 Consider the following organic compound:



9.3.1 Write down the IUPAC name of this compound. (2)

9.3.2 Write down the names of the two organic compounds that were used to prepare this compound. (4)

9.3.3 Write down the structural formula and IUPAC name of one isomer of this compound. (3)

[18]

TOTAL: 200

Senior Certificate Examination

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)

TABLE 1: PHYSICAL CONSTANTS
TABEL 1: FISIESE KONSTANTES

Avogadro'sconstant *Avogadro-konstante*	N_A of/or L	$6{,}02 \times 10^{23}$ mol^{-1}
Molar gas constant *Molêre gaskonstante*	R	8,31 J.K^{-1}.mol^{-1}
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.mol^{-1}
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K

TABLE 2: FORMULAE
TABEL 2: FORMULES

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

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

KEY/*SLEUTEL*

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Relative atomic mass (approximately)
Relatiewe atoommassa (benaderd)

I	II	III	IV	V	VI	VII	0
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

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

Increasing oxidising ability / *Toenemende oksideervermoë* ↑

↓ Increasing reducing ability / *Toenemende reduseervermoë*

Halfreaksie / Half-reaction	E° /volt
$F_2 + 2e^- \rightleftharpoons 2F^-$	+2,87
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+1,51
$Au^{3+} + 3e^- \rightleftharpoons Au$	+1,42
$C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$	+1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+1,33
$O_2 + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+1,21
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+1,20
$Br_2 + 2e^- \rightleftharpoons 2Br^-$	+1,09
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO + 2H_2O$	+0,96
$Ag^+ + e^- \rightleftharpoons Ag$	+0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2 + H_2O$	+0,80
$Hg^{2+} + 2e^- \rightleftharpoons Hg$	+0,79
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+0,77
$O_2 + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+0,54
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2 + 2H_2O$	+0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S$	+0,14
$\mathbf{2H^+ + 2e^- \rightleftharpoons H_2}$	**0,00**
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	-0,04
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	-0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	-0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	-0,25
$Co^{2+} + 2e^- \rightleftharpoons Co$	-0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	-0,40
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	-0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	-0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	-0,76
$2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^-$	-0,83
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	-1,18
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	-1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	-2,37
$Na^+ + e^- \rightleftharpoons Na$	-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

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

Increasing oxidising ability / *Toenemende oksideervermoë* ↓

Increasing reducing ability / *Toenemende reduseervermoë* ↑

Half-reaction / Halfreaksie	E° /volt
$Li^+ + e^- \rightleftharpoons Li$	-3,05
$K^+ + e^- \rightleftharpoons K$	-2,93
$Cs^+ + e^- \rightleftharpoons Cs$	-2,92
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	-2,90
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	-2,89
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	-2,87
$Na^+ + e^- \rightleftharpoons Na$	-2,71
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	-2,37
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	-1,66
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	-1,18
$2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^-$	-0,83
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	-0,76
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	-0,74
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	-0,44
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	-0,40
$Co^{2+} + 2e^- \rightleftharpoons Co$	-0,28
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	-0,25
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	-0,14
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	-0,13
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	-0,04
$\mathbf{2H^+ + 2e^- \rightleftharpoons H_2}$	**0,00**
$S + 2H^+ + 2e^- \rightleftharpoons H_2S$	+0,14
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+0,15
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+0,16
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2 + 2H_2O$	+0,17
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+0,34
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+0,40
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+0,45
$I_2 + 2e^- \rightleftharpoons 2I^-$	+0,54
$O_2 + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+0,68
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+0,77
$Hg^{2+} + 2e^- \rightleftharpoons Hg$	+0,79
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2 + H_2O$	+0,80
$Ag^+ + e^- \rightleftharpoons Ag$	+0,80
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO + 2H_2O$	+0,96
$Br_2 + 2e^- \rightleftharpoons 2Br^-$	+1,09
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+1,20
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+1,21
$O_2 + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+1,33
$C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$	+1,36
$Au^{3+} + 3e^- \rightleftharpoons Au$	+1,42
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+1,51
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$F_2 + 2e^- \rightleftharpoons 2F^-$	+2,87