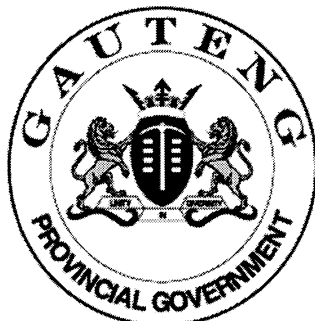


**SENIOR CERTIFICATE  
EXAMINATION  
SENIORSERTIFIKAAT-EKSAMEN**



**FEBRUARY / FEBRUARIE  
MARCH / MAART**

**2005**

**FUNCTIONAL PHYSICAL  
SCIENCE**

***FUNKSIONELE  
NATUUR-EN  
SKEIKUNDE***

**(Second Paper: Chemistry)  
(Tweede Vraestel: Chemie)**



**305-2/2**

FUNCTIONAL PHYSICAL SCIENCE SG: Paper 2

**12 pages  
12 bladsye**



**X05**



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GAUTENGSE DEPARTEMENT VAN ONDERWYS

SENIORSERTIFIKAAT-EKSAMEN

FUNKSIONELE NATUUR- EN  
SKEIKUNDE SG  
(Tweede Vraestel: Chemie)

TYD: 2 uur

PUNTE: 150

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**BENODIGDHEDE:**

- 'n Goedgekeurde (nie-programmeerbare, wetenskaplike) sakrekenaar. Kandidate moet hulle eie sakrekenaars voorsien.

**INSTRUKSIES:**

- Skryf jou eksamennommer in die spasies wat voor op die antwoordboek daarvoor voorsien word.
  - Beantwoord ALLE vrae.
  - Beantwoord Vraag 1 op die **antwoordblad** aan die **binnekant van die omslag** van jou **antwoordboek**. Trek 'n kruisie (X) oor die letter **A, B, C** of **D** om aan te dui watter letter jy kies.
  - Beantwoord alle ander vrae in die antwoordboek. Indien jy 'n antwoord moet oordoen, moet dit op 'n nuwe bladsy gedoen word. Nommer alle antwoorde duidelik.
  - Begin elke vraag op 'n nuwe bladsy.
  - 'n Datatabel word aan die einde van hierdie vraestel voorsien. Dit bevat formules en konstantes. Die inligting wat voorsien word, mag jou in die beantwoording van die vrae van hulp wees.
  - Rofwerk mag agter in jou antwoordboek op die blanko bladsye gedoen word.
- 
-

**GAUTENG DEPARTMENT OF EDUCATION**

**SENIOR CERTIFICATE EXAMINATION**

**FUNCTIONAL PHYSICAL SCIENCE SG  
(Second Paper: Chemistry)**

**TIME: 2 hours**

**MARKS: 150**

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**REQUIREMENTS:**

- An approved (non-programmable, scientific) pocket calculator. Candidates should supply their own calculators.

**INSTRUCTIONS:**

- Write your examination number in the spaces provided for this purpose on the front of your answer book.
  - Answer ALL questions.
  - Answer Question 1 on the **answer sheet** on the **inside cover** of your **answer book**. Make a cross (X) over the letter **A, B, C** or **D**, to indicate the letter you have chosen.
  - Answer all the other questions in the answer book. If you need to redo an answer, redo it on a new page. Number all answers clearly.
  - Start each question on a new page.
  - A data sheet is provided at the end of this question paper. It contains formulae and constants. The information provided may be useful in answering the questions.
  - Rough work may be done on the blank pages at the back of your answer book.
- 
-

VRAAG 1  
MEERVOUDIGE KEUSEVRAE

Bestudeer elke item en die voorgestelde antwoorde wat deur die letters **A, B, C** en **D** aangedui word. Maak 'n kruisie (**X**) oor die ooreenstemmende letter op die antwoordblad nadat jy besluit het watter antwoord die korrekte een is. As daar meer as een kruisie in enige antwoord voorkom, sal GEEN PUNTE toegeken word nie.

VOORBEELD:

Suiwer ys smelt by:

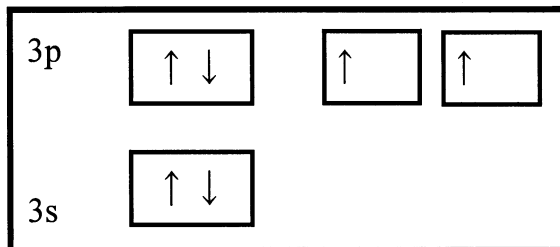
- A.  $-4^{\circ}\text{C}$
- B.  $0^{\circ}\text{C}$
- C.  $0\text{ K}$
- D.  $4^{\circ}\text{C}$

ANTWOORD: 

A	<del>X</del>	C	D
---	--------------	---	---

VRAAG 1

Vrae 1.1 tot 1.3 berus op die volgende Aufbaudiagram wat die energievakke van elektrone in die grondtoestand voorstel.



1.1 Hierdie element is

- A. C
- B. O
- C. S
- D. P

1.2 Die normale ioonlading van hierdie element is

- A.  $3^{+}$
- B.  $2^{-}$
- C.  $4^{+}$
- D.  $4^{-}$

QUESTION 1  
MULTIPLE-CHOICE QUESTIONS

Study each item and the suggested answers which are indicated by the letters **A**, **B**, **C** and **D**. Make a cross (**X**) over the corresponding letter on the answer sheet after you have decided which is the correct one. If more than one cross appears in any answer, **NO MARKS** will be awarded.

**EXAMPLE:**

Pure ice melts at:

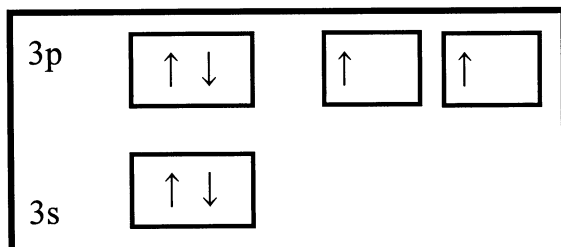
- A.  $-4^{\circ}\text{C}$
- B.  $0^{\circ}\text{C}$
- C. 0 K
- D.  $4^{\circ}\text{C}$

ANSWER:

A	<del>B</del>	C	D
---	--------------	---	---

QUESTION 1

Questions 1.1 to 1.3 refer to the following Aufbau diagram which represents the energy levels of the electrons in the ground state:



1.1 This element is

- A. C
- B. O
- C. S
- D. P

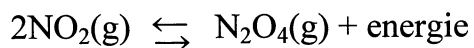
1.2 The normal ionic charge of this element is

- A.  $3^{+}$
- B.  $2^{-}$
- C.  $4^{+}$
- D.  $4^{-}$

- 1.3 Uit watter groep kom hierdie element?
- A. II
  - B. IV
  - C. V
  - D. VI
- 1.4 Die kookpunt van water is hoër as wat verwag word omdat
- A. water 'n ioniese binding is.
  - B. water 'n vloeistof is.
  - C. daar swak Van der Waalskragte tussen watermolekules bestaan.
  - D. daar sterk waterstofbindings tussen watermolekules bestaan.
- 1.5 Die twee elemente wat sal verbind om die sterkste ioniese verbinding te vorm is
- A.  $C + O_2$
  - B.  $C + H_2$
  - C.  $Cl_2 + H_2$
  - D.  $K + F_2$
- 1.6 As Y onoplosbaar is in water, maar in koolstoftetrachloried ( $CCl_4$ ) oplos, moet Y
- A. nie-polêr wees.
  - B. uit ione bestaan.
  - C. sterk intermolekulêre kragte hê.
  - D. polêr wees.
- 1.7 In 'n ewewigsreaksie sal 'n katalisator
- A. die ewewig verskuif na die reagense.
  - B. die ewewig verskuif na die produkte.
  - C. die ewewig vinniger teweegbring.
  - D. die temperatuur van die reaksie verhoog.

- 1.3 In which group will this element be found?
- II
  - IV
  - V
  - VI
- 1.4 The boiling point of water is higher than expected because of
- the ionic bonds in water.
  - water being a liquid.
  - weak Van der Waals forces between the water molecules.
  - the strong hydrogen bonds between water molecules.
- 1.5 The two elements which will combine to form the strongest ionic bond are
- C + O<sub>2</sub>
  - C + H<sub>2</sub>
  - Cl<sub>2</sub> + H<sub>2</sub>
  - K + F<sub>2</sub>
- 1.6 If Y does not dissolve in water but dissolves in carbon tetrachloride (CCl<sub>4</sub>), Y must
- be non-polar.
  - consist of ions.
  - have strong intermolecular forces.
  - be polar.
- 1.7 In an equilibrium reaction a catalyst will
- shift the equilibrium towards the reactants.
  - shift the equilibrium towards the products.
  - bring about equilibrium faster.
  - increase the temperature of the reaction.

1.8



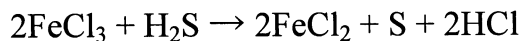
Die ewewigskonsentrasie van  $\text{N}_2\text{O}_4(\text{g})$  kan volgens die bostaande reaksie verhoog word deur

- A. die druk te verhoog.
- B. die druk te verlaag.
- C. die temperatuur te verhoog.
- D. die konsentrasie van die  $\text{NO}_2$  te verlaag.

1.9 Die oksidasietoestand van stikstof (N) in die verbinding  $\text{NO}_2^-$  is

- A. -1
- B. -6
- C. +3
- D. +5

1.10 In die volgende reaksie is die reduseermiddel



- A.  $\text{Fe}^{+3}$
- B.  $\text{S}^{-2}$
- C.  $\text{Fe}^{+2}$
- D.  $\text{S}^{\circ}$

1.11 Elektroliete is oplossings wat

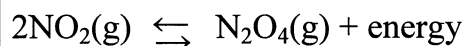
- A. nie ladings kan gelei nie.
- B. positiewe en negatiewe ione bevat.
- C. slegs molekules bevat.
- D. molekules en ione bevat.

1.12 Gedurende die elektrolise van 'n  $\text{CuCl}_2$ -oplossing vind die volgende reaksie by die **anode** plaas:

- A.  $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$
- B.  $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$
- C.  $2\text{Cu}^{+2} + 2\text{e}^- \rightarrow \text{Cu}$
- D.  $\text{Cu} \rightarrow \text{Cu}^{+2} + 2\text{e}^-$



1.8



The equilibrium concentration of  $\text{N}_2\text{O}_4(\text{g})$  can be increased, according to the above reaction, through

- A. increasing the pressure.
- B. decreasing the pressure.
- C. increasing the temperature.
- D. decreasing the concentration of  $\text{NO}_2$ .

1.9 The oxidation state of nitrogen (N) in the compound  $\text{NO}_2^-$  is

- A. -1
- B. -6
- C. +3
- D. +5

1.10 In the following reaction, the reducing agent is:



- A.  $\text{Fe}^{+3}$
- B.  $\text{S}^{-2}$
- C.  $\text{Fe}^{+2}$
- D.  $\text{S}^{\circ}$

1.11 Electrolytes are solutions which

- A. cannot conduct charges.
- B. contain positive and negative ions.
- C. contain only molecules.
- D. contain molecules and ions.

1.12 During electrolysis of a  $\text{CuCl}_2$  solution, the following reaction occurs at the **anode**:

- A.  $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$
- B.  $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$
- C.  $2\text{Cu}^{+2} + 2\text{e}^- \rightarrow \text{Cu}$
- D.  $\text{Cu} \rightarrow \text{Cu}^{+2} + 2\text{e}^-$

1.13 Die elemente in Groep I op die Periodieke Tabel sal maklik

- A. elektrone afgee.
- B. protone afgee.
- C. protone opneem.
- D. elektrone opneem.

1.14 Die halogene staan bekend as

- A. swak oksideermiddels.
- B. swak reduseermiddels.
- C. sterk reduseermiddels.
- D. sterk oksideermiddels.

1.15



Hierdie formule verteenwoordig

- A. Etaan
- B. Etanol
- C. Etyn
- D. Etanaal

15x3=[45]

## VRAAG 2 ATOOMSTRUKTUUR

'n Sekere element A lê in Groep VI van die Periodieke Tabel.

- 2.1 Wat is die normale valensie van hierdie element? (2)
- 2.2 Gee die ioonlading van hierdie element. (2)
- 2.3 Hoeveel halfgevolle orbitale het die element? (2)
- 2.4 Skryf 'n chemiese vergelyking neer om die vorming van 'n ioon van hierdie element aan te toon. (3)

[9]

1.13 The elements in Group I on the Periodic Table, easily

- A. donate electrons.
- B. donate protons.
- C. accept protons.
- D. accept electrons.

1.14 The halogens are known as

- A. weak oxidising agents.
- B. weak reducing agents.
- C. strong reducing agents.
- D. strong oxidising agents.

1.15



This formula represents:

- A. Ethane
- B. Ethanol
- C. Ethyne
- D. Ethanal

15x3=[45]

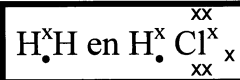
**QUESTION 2**  
**ATOMIC STRUCTURE**

A certain element A lies in Group VI on the periodic table.

- 2.1 What is the normal valence of this element? (2)
  - 2.2 Give the ion charge of this element. (2)
  - 2.3 How many half-filled orbitals does this element have? (2)
  - 2.4 Write down a chemical equation to show how this element forms an ion. (3)
- [9]**

### VRAAG 3 CHEMIESE BINDING

Die volgende molekules ontstaan as gevolg van elektrondeling soos in die blok hieronder voorgestel word:



- 3.1 Noem die tipe binding wat vorm as elektrone gedeel word. (2)
  - 3.2 In watter een van die twee molekules word die elektrone nie gelykop gedeel nie? (2)
  - 3.3 Noem die tipe binding waarin elektrone nie gelykop gedeel word nie. (2)
  - 3.4 Bereken die persentasie ioniese aard van die bindings van hierdie molekule. Gebruik die inligtingsblad. (4)
- [10]**

### VRAAG 4 INTERMOLEKULÊRE KRAGTE

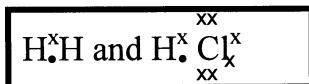
- 4.1 Chloor is 'n gas. Broom is 'n vloeistof en jodium, 'n vastestof. Hulle kom almal voor in Groep VII. Met verwysing na die aard en die sterkte van die bindings tussen die molekules, verklaar waarom hulle by kamertemperatuur in verskillende fases (vorms) voorkom. (4)
  - 4.2 'n Watermolekule is polêr. Teken 'n benoemde diagram van 'n watermolekule, om die fatsoen en die polariteit daarvan aan te toon. (4)
  - 4.3 Watter tipe intermolekulêre kragte bestaan hoofsaaklik tussen watermolekules? (2)
- [10]**

### VRAAG 5 ENERGIE EN CHEMIESE BINDING

- 5.1 Verduidelik die verskil tussen endo- en eksotermiese reaksies met behulp van eenvoudige potensiële-energiediagramme. (4)
  - 5.2 Indien ammoniumchloried in water oplos, voel die oplossing koud. Is hierdie proses endo- of eksotermies? Verduidelik jou antwoord kortliks. (3)
- [7]**

**QUESTION 3**  
**CHEMICAL BONDING**

The following molecules originate because of electron sharing, shown in the block below:



- 3.1 Name the type of bond formed when electrons are shared. (2)
- 3.2 In which of the two molecules are the electrons not shared equally? (2)
- 3.3 Name the type of bond where electrons are not shared equally. (2)
- 3.4 Calculate the percentage of ionic character in the bonds of this molecule. Use the information page. (4)

**[10]**

**QUESTION 4**  
**INTERMOLECULAR FORCES**

- 4.1 Chlorine is a gas. Bromine is a liquid and iodine a solid. They are all in Group VII. Referring to the type and strength of bonds between the molecules, explain why they are all in different forms at room temperature. (4)
- 4.2 A water molecule is polar. Draw a labelled diagram of a water molecule to show the form and polarity thereof. (4)
- 4.3 What type of intermolecular forces exist between water molecules? (2)

**[10]**

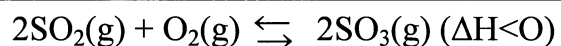
**QUESTION 5**  
**ENERGY AND CHEMICAL BONDING**

- 5.1 Explain the difference between endo- and exothermic reactions by means of simple potential energy diagrams. (4)
- 5.2 When ammonium chloride dissolves in water it feels cold. Is this process endo- or exothermic? Explain your answer briefly. (3)

**[7]**

**VRAAG 6**  
**CHEMIESE EWEWIG**

Die reaksie wat deur die volgende vergelyking voorgestel word, het ewewig bereik.



- 6.1 Wat word die stof genoem wat gebruik kan word om die bereiking van chemiese ewewig te versnel (vinniger te maak)? (2)
- 6.2 Watter gas moet gereeld uit die houer verwyder word om te verseker dat meer SO<sub>3</sub>-gas sal vorm? (2)
- 6.3 Watter uitwerking sal 'n verhoging in temperatuur hê op
- 6.3.1 hierdie ewewig? (3)
- 6.3.2 die tempo van die voorwaartse en terugwaartse reaksie in ewewig? (2)
- 6.4 Watter uitwerking sal 'n verlaging in druk hê op die konsentrasie van SO<sub>3</sub> by ewewig? (2)
- 6.5 Waarom is dit belangrik om die chemiese ewewig te beheer? (2)
- [13]

**VRAAG 7**  
**REDOKSREAKSIES**

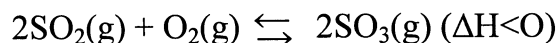
- 7.1 Bereken die oksidasiegetal van Cr in Na<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>. (3)
- 7.2 Verduidelik deur te verwys na oksidasiegetalle, wat die term **reduksie** beteken. (2)
- 7.3 Beskou die volgende ongebalanseerde vergelyking wat 'n redoksreaksie voorstel.



- 7.3.1 Wat sal die verandering in die oksidasiegetal van mangaan in hierdie reaksie wees? (2)
- 7.3.2 Skryf die oksidasiehalfreaksie neer. (3)
- 7.3.3 Watter stof is die reduseermiddel? (2)
- 7.3.4 Balanseer die vergelyking. (4)
- [16]

**QUESTION 6**  
**CHEMICAL EQUILIBRIUM**

The reaction represented by the following equation, has reached equilibrium.



- 6.1 What is the substance called that can be used to accelerate the attainment of chemical equilibrium? (2)
- 6.2 Which gas should be removed frequently to ensure a high production of SO<sub>3</sub> gas? (2)
- 6.3 What effect would an increase in temperature have on
- 6.3.1 this equilibrium? (3)
- 6.3.2 the rate of the forward and reverse reactions at equilibrium? (2)
- 6.4 What effect would a decrease in pressure have on the concentration of SO<sub>3</sub> at equilibrium? (2)
- 6.5 Why is it important to control chemical equilibrium? (2)
- [13]**

**QUESTION 7**  
**REDOX REACTIONS**

- 7.1 Calculate the oxidation number of Cr in Na<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>. (3)
- 7.2 Explain by referring to oxidation numbers, what the term **reduction** means. (2)
- 7.3 Consider the following unbalanced equation, that represents a redox reaction.

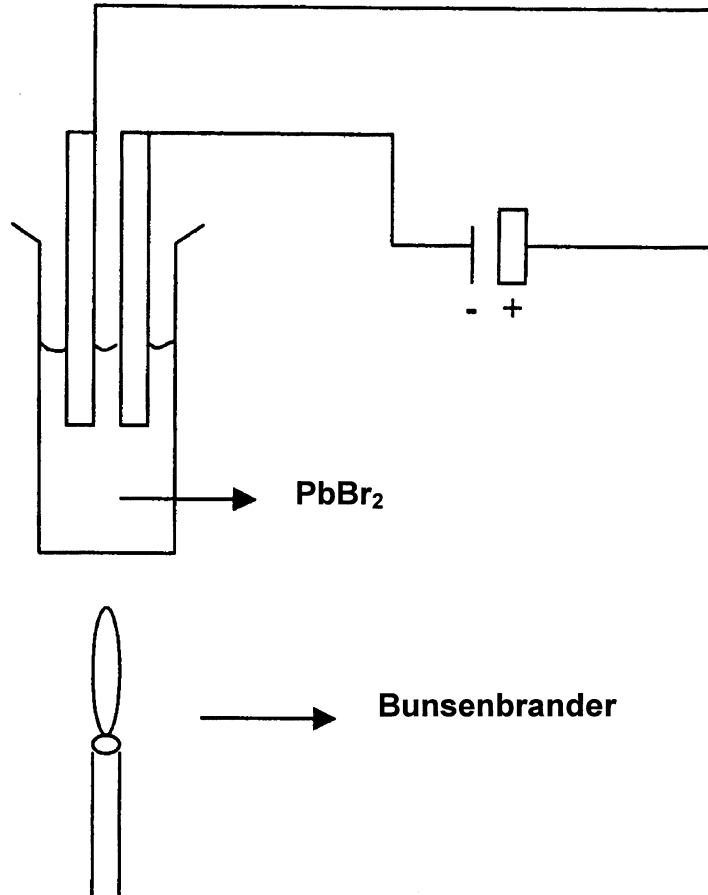


- 7.3.1 What would the change in the oxidation number of manganese be in this reaction? (2)
- 7.3.2 Write down the oxidation half reaction. (3)
- 7.3.3 Which substance is the reducing agent? (2)
- 7.3.4 Balance the equation. (4)

**[16]**

VRAAG 8  
ELEKTROCHEMIE

Gesmelte loodbromied ( $\text{PbBr}_2$ ) ondergaan elektrolise met twee koolstofelektrodes in 'n proefbuis.



- 8.1 Wat word 'n vloeistof soos gesmelte loodbromied genoem, wat 'n elektriese stroom kan gelei? (2)
- 8.2 Wat word die koolstofelektrode genoem wat aan die positiewe pool van die sel verbind word? (2)
- 8.3 Waarom is dit nodig om die sel te verhit? (2)
- 8.4 Noem die produkte wat sal vorm tydens die elektrolise van loodbromied. (4)
- 8.5 Skryf ioniese vergelykings vir die reaksies by die
- 8.5.1 positiewe elektrode. (3)
- 8.5.2 negatiewe elektrode. (3)

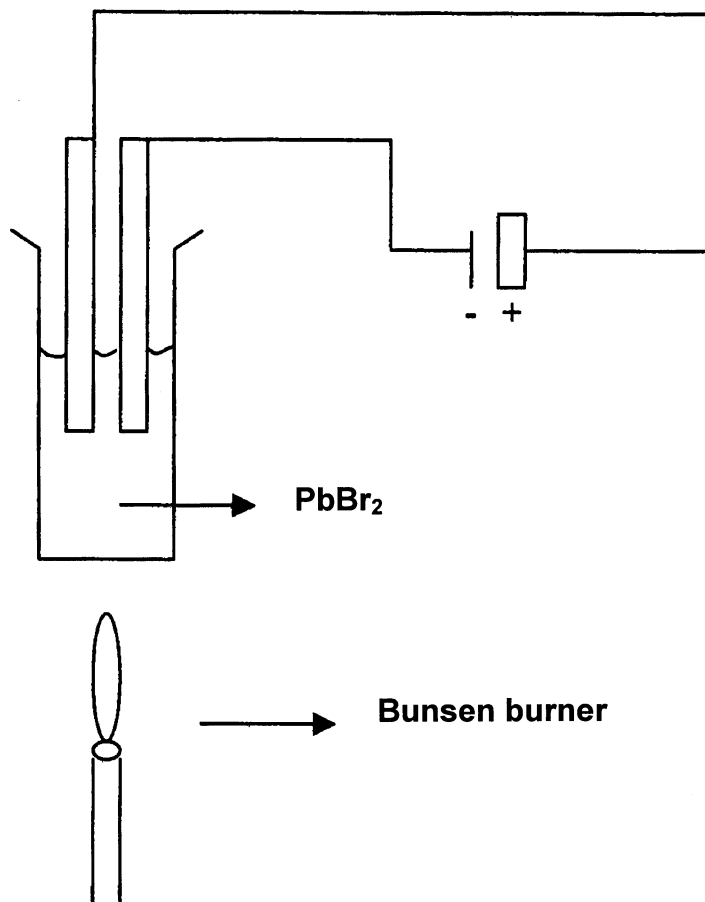
[16]

b.o.



**QUESTION 8**  
**ELECTRO CHEMISTRY**

Molten lead bromide ( $\text{PbBr}_2$ ) is electrolysed with two carbon electrodes in a test tube.



- 8.1 What is the term used for a liquid like lead bromide, which can conduct electricity? (2)
- 8.2 What do we call the carbon electrode which is connected to the positive pole of the cell? (2)
- 8.3 Why is it necessary to heat the cell? (2)
- 8.4 Name the products that will form when lead bromide is electrolysed. (4)
- 8.5 Write down the ionic equations for the reactions at the
- 8.5.1 positive electrode. (3)
- 8.5.2 negative electrode. (3)

[16]

VRAAG 9  
EIENSKAPPE VAN ELEMENTE

- 9.1 Skryf in elk van die volgende gevalle die kleurverandering neer wat plaasvind wanneer
- 9.1.1 chloorwater by 'n natriumbromiedoplossing gevoeg word. (2)
- 9.1.2 broomwater by 'n natriumjodiedoplossing gevoeg word. (2)
- 9.1.3 chloorwater by 'n kaliumjodiedoplossing gevoeg word. (2)
- 9.2 9.2.1 Skryf jou waarneming neer indien 'n klein stukkie natrium in 'n bak met water gegooi word. (4)
- 9.2.2 Watter kleur sal lakmoes word as dit in die water geplaas word? (1)
- 9.2.3 Watter stof word gevorm en waarom verander die lakmoes se kleur? (3)
- [14]

VRAAG 10  
ORGANIESE CHEMIE

Bestudeer die tabel hieronder en skryf dan die vraagnommer en die ontbrekende inligting daarnaas neer.

IUPAC NAAM	STRUKTUUR	FUNKSIONELE GROEP (STRUKTUUR)	FUNKSIONELE GROEP (NAAM)
10.1	$\begin{array}{c} \text{H} \quad \text{O} \\   \quad    \\ \text{H}-\text{C}-\text{C}-\text{OH} \\   \\ \text{H} \end{array}$	$\begin{array}{c} \text{O} \\    \\ -\text{C}-\text{OH} \end{array}$	Karboksielsure
Etanol	10.2	$\begin{array}{c} \text{H} \\   \\ -\text{C}-\text{OH} \\   \\ \text{H} \end{array}$	10.3
10.4	$\begin{array}{c} \text{H} \quad \text{H} \\ \diagdown \quad   \quad   \\ \text{C}=\text{C}-\text{C}-\text{H} \\ \diagup \quad \quad   \\ \text{H} \quad \quad \text{H} \end{array}$	$-\text{C}=\text{C}-$	10.5

[10]

TOTAAL: 150

b.o.

**QUESTION 9**  
**PROPERTIES OF ELEMENTS**

- 9.1 Write down in each of the following instances the colour change that occurs when
- 9.1.1 chlorine water is added to a sodium bromide solution. (2)
- 9.1.2 bromine water is added to a sodium iodide solution. (2)
- 9.1.3 chlorine water is added to a potassium iodide solution. (2)
- 9.2 9.2.1 Write down your observation when a small piece of sodium is added to a bowl with water. (4)
- 9.2.2 What colour would litmus turn when it is placed in the water? (1)
- 9.2.3 What substance is formed and why does the litmus change colour? (3)
- [14]**

**QUESTION 10**  
**ORGANIC CHEMISTRY**

Study the table below and write down the question number and the missing information next to it.

IUPAC NAME	STRUCTURE	FUNCTIONAL GROUP (STRUCTURE)	FUNCTIONAL GROUP (NAME)
<b>10.1</b>	$\begin{array}{c} \text{H} \quad \text{O} \\   \quad    \\ \text{H}-\text{C}-\text{C}-\text{OH} \\   \\ \text{H} \end{array}$	$\begin{array}{c} \text{O} \\    \\ -\text{C}-\text{OH} \end{array}$	Carboxylic acids
Ethanol	<b>10.2</b>	$\begin{array}{c} \text{H} \\   \\ -\text{C}-\text{OH} \\   \\ \text{H} \end{array}$	<b>10.3</b>
<b>10.4</b>	$\begin{array}{c} \text{H} \quad \text{H} \\   \quad   \\ \text{H} \diagdown \text{C} = \text{C} - \text{C} - \text{H} \\   \\ \text{H} \end{array}$	$-\text{C} = \text{C} -$	<b>10.5</b>

**[10]**

**TOTAL: 150**



THE PERIODIC TABLE OF ELEMENTS  
 DIE PERIODIEKE TABEL VAN ELEMENTE

**SLEUTEL / KEY**

Atoomgetal Atomic number	29 Cu 63,5	Simbool Symbol
Elektronegatiwiteit Electronegativity	→	←
Relative atoommassa (benaderd) Relative atomic mass (approximately)	←	→

I	II	III	IV	V	VI	VII	0
1 H 1	4 Be 9	5 B 11	6 C 12	7 N 14	8 O 16	9 F 19	2 He 4
3 Li 7	12 Mg 24	13 Al 27	14 Si 28	15 P 31	16 S 32	17 Cl 35,5	10 Ne 20
11 Na 23	20 Ca 40	19 K 39	31 Ga 70	32 Ge 73	33 As 75	34 Se 79	18 Ar 40
19 K 39	38 Sr 88	21 Sc 45	30 Zn 65	39 Y 89	40 Zr 91	41 Nb 92	36 Kr 84
37 Rb 86	88 Ba 137	22 Ti 48	29 Cu 63,5	37 Rb 85	38 Sr 88	39 Y 89	54 Xe 131
55 Cs 133	87 Fr 226	23 V 51	28 Ni 59	46 Pd 106	47 Ag 108	48 Cd 112	86 Rn
		24 Cr 52	27 Co 59	45 Rh 103	46 Pd 106	47 Ag 108	
		25 Mn 55	26 Fe 56	44 Ru 101	45 Rh 103	46 Pd 106	
		41 Nb 92	42 Mo 96	73 Ta 181	74 W 184	75 Re 186	
		40 Zr 91	43 Tc 101	76 Os 190	77 Ir 192	78 Pt 195	
		72 Hf 179	73 Ta 181	80 Hg 201	81 Tl 204	82 Pb 207	
		89 Ac		197 Au	198 Pt	199 Au	
				201 Hg	202 Tl	203 Pb	
				204 Tl	205 Pb	206 Bi	
				207 Pb	208 Bi	209 Po	
				209 Bi	210 Po	211 At	
				210 Po	211 At	212 Rn	
				211 At	212 Rn	213 Fr	
				212 Rn	213 Fr	214 Ra	
				213 Fr	214 Ra	215 Ac	
				214 Ra	215 Ac	216 Th	
				215 Ac	216 Th	217 Pa	
				216 Th	217 Pa	218 U	
				217 Pa	218 U	219 Np	
				218 U	219 Np	220 Pu	
				219 Np	220 Pu	221 Am	
				220 Pu	221 Am	222 Cm	
				221 Am	222 Cm	223 Bk	
				222 Cm	223 Bk	224 Cf	
				223 Bk	224 Cf	225 Es	
				224 Cf	225 Es	226 Fm	
				225 Es	226 Fm	227 Md	
				226 Fm	227 Md	228 No	
				227 Md	228 No	229 Lr	
				228 No	229 Lr	230 La	
				229 Lr	230 La	231 Ce	
				230 La	231 Ce	232 Pr	
				231 Ce	232 Pr	233 Nd	
				232 Pr	233 Nd	234 Pm	
				233 Nd	234 Pm	235 Sm	
				234 Pm	235 Sm	236 Eu	
				235 Sm	236 Eu	237 Gd	
				236 Eu	237 Gd	238 Tb	
				237 Gd	238 Tb	239 Dy	
				238 Tb	239 Dy	240 Ho	
				239 Dy	240 Ho	241 Er	
				240 Ho	241 Er	242 Tm	
				241 Er	242 Tm	243 Yb	
				242 Tm	243 Yb	244 Lu	
				243 Yb	244 Lu	245 Hf	
				244 Lu	245 Hf	246 Ta	
				245 Hf	246 Ta	247 W	
				246 Ta	247 W	248 Re	
				247 W	248 Re	249 Os	
				248 Re	249 Os	250 Ir	
				249 Os	250 Ir	251 Pt	
				250 Ir	251 Pt	252 Au	
				251 Pt	252 Au	253 Hg	
				252 Au	253 Hg	254 Tl	
				253 Hg	254 Tl	255 Pb	
				254 Tl	255 Pb	256 Bi	
				255 Pb	256 Bi	257 Po	
				256 Bi	257 Po	258 At	
				257 Po	258 At	259 Rn	
				258 At	259 Rn	260 Fr	
				259 Rn	260 Fr	261 Ra	
				260 Fr	261 Ra	262 Ac	
				261 Ra	262 Ac	263 Th	
				262 Ac	263 Th	264 Pa	
				263 Th	264 Pa	265 U	
				264 U	265 Np	266 Pu	
				265 Np	266 Pu	267 Am	
				266 Pu	267 Am	268 Cm	
				267 Am	268 Cm	269 Bk	
				268 Cm	269 Bk	270 Cf	
				269 Bk	270 Cf	271 Es	
				270 Cf	271 Es	272 Fm	
				271 Es	272 Fm	273 Md	
				272 Fm	273 Md	274 No	
				273 Md	274 No	275 Lr	
				274 No	275 Lr	276 La	
				275 Lr	276 La	277 Ce	
				276 La	277 Ce	278 Pr	
				277 Ce	278 Pr	279 Nd	
				278 Pr	279 Nd	280 Pm	
				279 Nd	280 Pm	281 Sm	
				280 Pm	281 Sm	282 Eu	
				281 Eu	282 Gd	283 Tb	
				282 Gd	283 Tb	284 Dy	
				283 Tb	284 Dy	285 Ho	
				284 Dy	285 Ho	286 Er	
				285 Ho	286 Er	287 Tm	
				286 Er	287 Tm	288 Yb	
				287 Tm	288 Yb	289 Lu	
				288 Yb	289 Lu	290 Hf	
				289 Lu	290 Hf	291 Ta	
				290 Hf	291 Ta	292 W	
				291 Ta	292 W	293 Re	
				292 W	293 Re	294 Os	
				293 Re	294 Os	295 Ir	
				294 Os	295 Ir	296 Pt	
				295 Ir	296 Pt	297 Au	
				296 Pt	297 Au	298 Hg	
				297 Au	298 Hg	299 Tl	
				298 Hg	299 Tl	300 Pb	
				299 Tl	300 Pb	301 Bi	
				300 Pb	301 Bi	302 Po	
				301 Bi	302 Po	303 At	
				302 Po	303 At	304 Rn	
				303 At	304 Rn	305 Fr	
				304 Rn	305 Fr	306 Ra	
				305 Fr	306 Ra	307 Ac	
				306 Ra	307 Ac	308 Th	
				307 Ac	308 Th	309 Pa	
				308 Th	309 Pa	310 U	
				309 Pa	310 U	311 Np	
				310 U	311 Np	312 Pu	
				311 Np	312 Pu	313 Am	
				312 Pu	313 Am	314 Cm	
				313 Am	314 Cm	315 Bk	
				314 Cm	315 Bk	316 Cf	
				315 Bk	316 Cf	317 Es	
				316 Cf	317 Es	318 Fm	
				317 Es	318 Fm	319 Md	
				318 Fm	319 Md	320 No	
				319 Md	320 No	321 Lr	



STANDARD REDUCTION POTENTIALS OF A NUMBER OF HALF-REACTIONS  
 STANDAARDREDUKSIEPOTENSIALE VAN VERSKEIE HALFREAKSIES

Half-reaction / Halfreaksie	$E^\ominus$ volts / volt
$\text{Li}^+ + \text{e}^- \rightleftharpoons \text{Li}$	-3,05
$\text{K}^+ + \text{e}^- \rightleftharpoons \text{K}$	-2,93
$\text{Cs}^+ + \text{e}^- \rightleftharpoons \text{Cs}$	-2,92
$\text{Ba}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ba}$	-2,90
$\text{Sr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sr}$	-2,89
$\text{Ca}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ca}$	-2,87
$\text{Na}^+ + \text{e}^- \rightleftharpoons \text{Na}$	-2,71
$\text{Mg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mg}$	-2,37
$\text{Al}^{3+} + 3\text{e}^- \rightleftharpoons \text{Al}$	-1,66
$\text{Mn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mn}$	-1,18
$2\text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{H}_2 + 2\text{OH}^-$	-0,83
$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	-0,76
$\text{Cr}^{3+} + 3\text{e}^- \rightleftharpoons \text{Cr}$	-0,74
$\text{Fe}^{2+} + 2\text{e}^- \rightleftharpoons \text{Fe}$	-0,44
$\text{Cd}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cd}$	-0,40
$\text{Co}^{2+} + 2\text{e}^- \rightleftharpoons \text{Co}$	-0,28
$\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}$	-0,25
$\text{Sn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sn}$	-0,14
$\text{Pb}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pb}$	-0,13
$\text{Fe}^{3+} + 3\text{e}^- \rightleftharpoons \text{Fe}$	-0,04
$2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2$	0,00
$\text{S} + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{S}$	+0,14
$\text{Sn}^{4+} + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{SO}_2 + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+0,40
$\text{SO}_2 + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{I}_2 + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	+0,68
$\text{Fe}^{3+} + \text{e}^- \rightleftharpoons \text{Fe}^{2+}$	+0,77
$\text{Hg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Hg}$	+0,79
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$	+0,80
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\text{l}) + 2\text{e}^- \rightleftharpoons 2\text{Br}^-$	+1,09
$\text{Pt}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pt}$	+1,20
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,21
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-$	+1,36
$\text{Au}^{3+} + 3\text{e}^- \rightleftharpoons \text{Au}$	+1,42
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,77
$\text{F}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{F}^-$	+2,87

Increasing oxidising ability /  
 Verhoogde oksideervermoë

Increasing reducing ability /  
 Verhoogde reduseervermoë

$E^\ominus$  CELL =  $E^\ominus$  CATHODE -  $E^\ominus$  ANODE /  $E^\ominus$  SEL =  $E^\ominus$  KATODE -  $E^\ominus$  ANODE

END / EINDE