GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

FUNCTIONAL PHYSICAL SCIENCE SG
(Second Paper: Chemistry)

FEB / MAR 2006

TIME: 2 hours

MARKS: 150

REQUIREMENTS:

- An approved (non-programmable scientific) pocket calculator. Candidates must provide their own calculators.

INSTRUCTIONS:

- Write your examination number in the spaces provided on the cover of your **answer book**.
- Answer ALL the questions.
- Answer Question 1 by making a cross (X) over letter A, B, C or D on the **answer sheet** on the **inside cover** of your **answer book** to indicate the letter you have chosen.
- Answer all other questions in the **answer book**. If you need to redo the answer, redo it on a blank page. Number these answers clearly.
- Information sheets are provided at the end of this paper. They contain equations, formulae and constants. The information may be useful in answering the questions.
- Rough work may be done on the blank pages at the **back** of the **answer book**.

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° C
B. 0° C
C. 0 K
D. 4° C

ANSWER:

A	~~B~~	C	D

QUESTION 1

1.1 An atom has an atomic number of 9 and a relative atomic mass of 19. How many neutrons will be found in a neutral atom?

A. 9
B. 19
C. 10
D. 8

1.2 When an electron is raised from a lower to a higher energy level in an atom, _____.

A. energy is liberated by the atom
B. the electron gains energy
C. the atomic nucleus loses energy
D. the atom becomes a negative ion

1.3 The most important conclusion that Rutherford made from his well-known gold foil experiment was that _____ .

A. the atom is a sphere of positive electricity in which electrons are scattered
B. the nucleus of the atoms is negatively charged
C. all matter is built up of small, solid, indestructible particles (atoms)
D. virtually the entire mass of the atom is concentrated in an extremely small nucleus

1.4 An element has the following electron configuration:

$1s^2 2s^2 2p^6 3s^2$

This element is found in the periodic table in

	Group	Period
A.	2	2
B.	2	3
C.	3	2
D.	3	4

1.5 The bond with the highest percentage ionic character is formed between atoms of the following elements:

A. sodium and chlorine
B. hydrogen and chlorine
C. hydrogen and oxygen
D. oxygen and sodium

1.6 Elements that find their valence electrons only in s-orbitals, are _____.

A. hydrogen, magnesium and alkali metals
B. noble gases
C. only elements in group I
D. only elements of group I, II and VIII

1.7 The three-dimensional space where electrons find themselves is called _____.

A. a cloud
B. sub-energy level
C. energy level
D. orbital

1.8 The bond between two atoms, where each atom provides an electron for the shared electron pair, is called a _____.

A. double bond
B. non-polar bond
C. covalent bond
D. ionic bond

1.9 Which of the following properties can be explained because of the presence of hydrogen bonds between molecules?

A. The electrical conductivity of carbon
B. The relatively high melting point of ice
C. The relatively high boiling point of magnesium
D. The electrical conductivity of a sodium chloride solution

1.10 Study the following reaction:

$$CuSO_4 + Zn^{2+} \rightleftharpoons ZnSO_4 + Cu^{2+}$$

The reducing agent is _____.

A. Cu
B. Cu^{2+}
C. Zn
D. Zn^{2+}

1.11 Which forward reaction (at equilibrium) is being favoured when the pressure is increased? (They are all gases.)

A. $2NH_3 \rightleftharpoons N_2 + 3H_2$
B. $2SO_3 \rightleftharpoons 2SO_2 + O_2$
C. $2NO \rightleftharpoons N_2 + O_2$
D. $2H_2 + O_2 \rightleftharpoons 2H_2O$

1.12 The following reaction has reached a state of equilibrium:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) + \text{energy}$$

The concentration of HI can be increased by _____.

A. reducing the temperature
B. increasing the temperature
C. increasing the pressure on the system
D. reducing the pressure on the system

1.13

$$Mg + Cu^{2+} \rightleftharpoons Mg^{2+} + Cu$$

In this reaction the electron donor is _____.

A. Mg
B. Cu^{2+}
C. Mg^{2+}
D. Cu

1.14 Which one of the following compounds is unsaturated?

A. C_4H_{10}
B. C_5H_{12}
C. C_3H_6
D. C_7H_{16}

1.15 Alkanes are organic compounds which all ____.

A. are gases at room temperature
B. have the formula C_nH_{2n+2}
C. contain only carbon and oxygen
D. very reactive substances

15x3=**[45]**

QUESTION 2
ATOMIC STRUCTURE

2.1 In an atom, electrons are found in energy levels around the nucleus.

2.1.1 At which energy level is an electron with the lowest energy found? (2)

2.1.2 What could happen to an electron if it receives enough energy? (2)

2.1.3 What is necessary to remove electrons from an atom? (2)

2.1.4 A. How does the energy of an electron change when it moves from a higher to a lower energy level? (1)

B. In what form is the released energy observed? (1)

2.1.5 What type of particle is formed when an atom

A. loses an electron? (2)

B. gains an electron? (2)

2.1.6 An atom of an element, X is represented by the following symbol: $^{40}_{19}X$.

A. Explain the terms

(a) atomic number. (2)

(b) mass number. (2)

B. Use the s, p, d notation to write down the electron configuration of the atom X. (3)

C. Write down the name, number and charge of the three elementary particles that an atom of this element consists of. Draw the following table in your answer book to complete the answer:

	Name	Number	Charge
1			
2			
3			

(9)

[28]

QUESTION 3
CHEMICAL BONDING AND INTERMOLECULAR FORCES

3.1 Hydrogen combines with oxygen to form water.

3.1.1 What type of bond exists between the atoms of hydrogen and oxygen? (2)

3.1.2 Use a Lewis diagram, e.g. H&H, to show how these bonds take place and to illustrate the shape of the water molecule. (2)

3.1.3 Name the type of bond between the water molecules in the liquid and solid state. (2)

3.1.4 Which one of the following conducts electricity the best: water or water with a few drops of sulphuric acid added? (2)

3.1.5 How does the boiling point of hydrogen sulphide compare with that of water under the same conditions? (2)

3.1.6 Give an explanation for your answer to Question 3.1.5. (2)

[12]

QUESTION 4
ENERGY AND CHEMICAL BONDING

4.1 When carbon combines with sulphur the following reaction takes place:

$$C(s) + 2S(s) \rightarrow CS_2(g); \quad \Delta H = 28{,}7 \text{ kJ/mol}$$

4.1.1 Is the reaction endothermic or exothermic? (2)

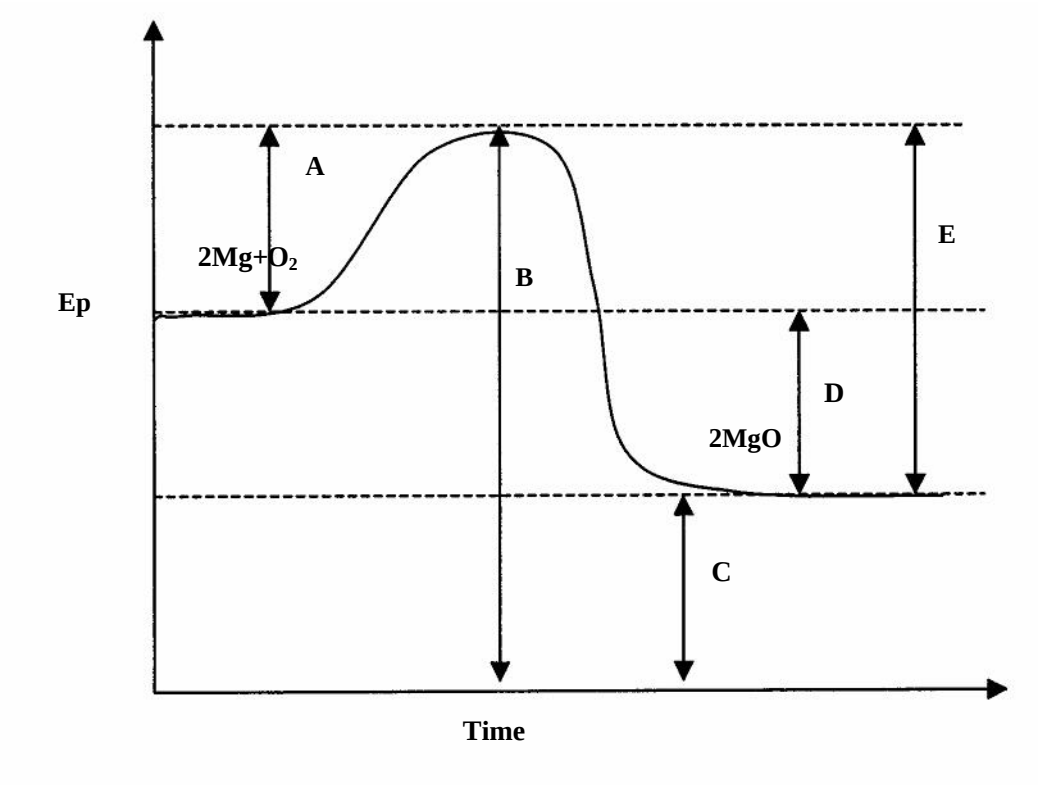
4.1.2 What do the letters (s) and (g) in the equation represent? (2)

4.1.3 When sugar is dissolved in water, heat is absorbed. Is this process endothermic or exothermic? (2)

4.2 A piece of magnesium ribbon burns in air to form magnesium oxide. The reaction can be represented as follows:

$$2\ Mg + O_2 \rightarrow 2\ MgO$$

Energy changes that take place during this reaction are shown in the diagram below:



4.2.1 Is the reaction exothermic or endothermic? (2)

4.2.2 Which interval on the graph represents the heat of the reaction? (2)

4.2.3 What is the nature of the activation energy in this reaction? (2)

[12]

QUESTION 5
CHEMICAL EQUILIBRIUM

5.1 The oxidation of sulphuric(IV)oxide to sulphur(VI)oxide is an essential step in the production of sulphuric acid.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H = -95 \text{ kJ/mol}$$

5.1.1 During the forward reaction a net amount of energy is released. Explain the origin of this excess energy. (2)

5.1.2 Which gas must continuously be removed from the reaction mixture to ensure a high yield of product? (2)

5.1.3 If the equilibrium in the reaction shifts so that the concentration of the reactants increases, what will happen to the pressure? (Assume that the volume and temperature remain constant.) (2)

5.1.4 Will the reverse reaction be exothermic or endothermic? (2)

5.1.5 What will the influence of a temperature increase be on the

A. yield of the product? (2)

B. speed of the forward and reverse reactions at equilibrium? (2)

5.1.6 What will the influence of a **decrease** in pressure be on the production of $SO_3(g)$? (2)

[14]

QUESTION 6
REDOX REACTIONS

6.1 Chlorine gas ($C1_2$) is bubbled through a solution of potassium bromide (KBr) in water.

6.1.1 What colour change do you observe in the solution? (2)

6.1.2 What substance, which forms is responsible for this change? (2)

6.1.3 For this reaction, write down the

A. oxidation half-reaction. (3)

B. reduction half-reaction. (3)

C. overall reaction. (3)

[13]

QUESTION 7
ELECTROCHEMISTRY

7.1 Draw a neat, labelled diagram of a electro-chemical cell (Cu / Zn). Show the direction of electron flow. (8)

7.2 Which half-cell is the anode and which is the cathode? (2)

7.3 Write down the chemical equation for the half-reaction that takes place at the zinc electrode. (3)

7.4 Write down the chemical equation for the reaction that takes place at the copper electrode. (3)
[16]

QUESTION 8
ORGANIC CHEMISTRY

8.1 8.1.1 Write down the structural formula for ethane and ethene. (2)

8.1.2 Which is a saturated compound? (2)

8.1.3 How would you test for saturation? (2)

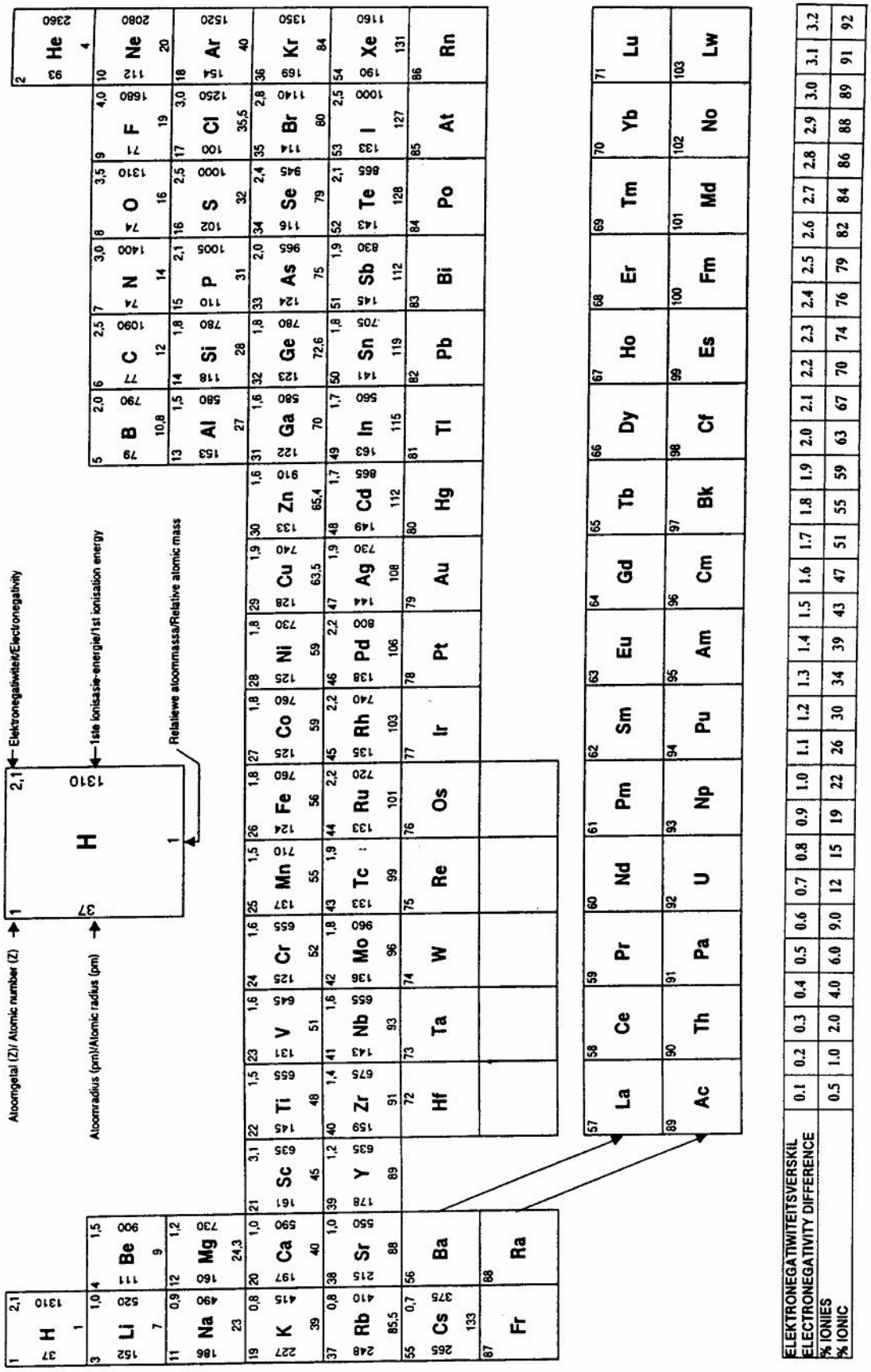
8.2 Write down a balanced chemical equation for the combustion of methane (CH_4) in oxygen. (2)

8.3 Give the IUPAC name for CH_3OH. (2)
[10]

TOTAL: 150

PERIODIEKE TABEL / PERIODIC TABLE

TABEL 2 / TABLE 2



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

Increasing oxidising ability / *Toenemende oksideervermoë* ↓

Increasing reducing ability / *Toenemende reduseervermoë* ↑

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

$E^\circ_{CELL} = E^\circ_{CATHODE} - E^\circ_{ANODE}$ / $E^\circ_{SEL} = E^\circ_{KATODE} - E^\circ_{ANODE}$

END / *EINDE*