basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

TECHNICAL SCIENCES P2

2022

MARKS: 75

TIME: 1½ hours

This question paper consists of 9 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of SIX questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You are advised to use the attached DATA SHEETS.

8. Round off your FINAL numerical answers to a minimum of TWO decimal places.

9. Give brief motivations, discussions, etc. where required.

10. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.5) in the ANSWER BOOK, e.g. 1.6 D.

1.1 The temperature at which the solid and liquid phases of a substance are at equilibrium is known as …

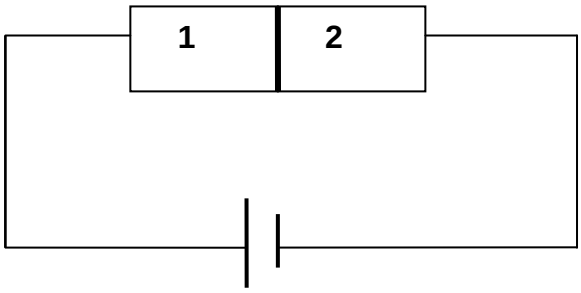
A vapour pressure.

B boiling point.

C melting point.

D viscosity. (2)

1.2 Consider the diagram of a p-n junction diode below:



Which ONE of the combinations below correctly represents part **1** and part **2**?

	1	**2**
A	p-type	p-type
B	p-type	n-type
C	n-type	p-type
D	n-type	n-type

(2)

1.3 Which ONE of the following combinations is TRUE about the substance that is oxidised?

	ELECTRONS	**OXIDATION NUMBER**
A	Gain	Decreases
B	Loss	Decreases
C	Gain	Increases
D	Loss	Increases

(2)

1.4 Which ONE of the following is an advantage of fuel (hydrogen) cell?

A Hydrogen extraction is very cheap.

B Hydrogen cell has minimal negative environmental impact, as it produces water only.

C Hydrogen gas is safer to handle and store.

D Hydrogen has a unique smell: therefore, it is easy to detect leaking pipes and containers. (2)

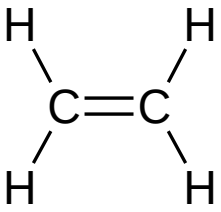
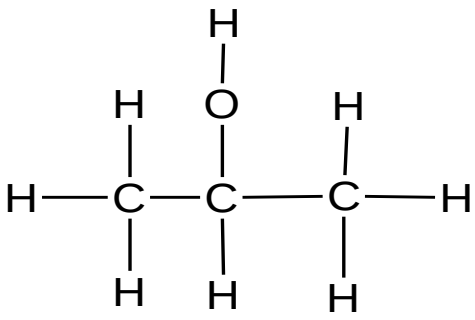
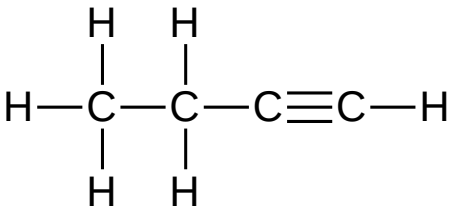
1.5 Which ONE of the following is CORRECT about the change in the mass of electrodes in a galvanic cell? Assume that both electrodes are solid metals.

	ANODE	**CATHODE**
A	Decreases	Increases
B	Decreases	Decreases
C	Increases	Increases
D	Increases	Decreases

(2)
[10]

QUESTION 2 (Start on a new page.)

Consider the organic molecules in the table below and answer the questions that follow.

A		**B**	
C	CH_3CH_2CHO	**D**	Propanone
E	C_4H_{10}	**F**	

2.1 Compounds **E** and **F** are hydrocarbons. For these compounds, write down the LETTER that represents a hydrocarbon which is:

2.1.1 Saturated (1)

2.1.2 Unsaturated (1)

2.2 Write down the general formula for a homologous series to which compound **F** belongs. (2)

2.3 Draw the structural formula for the functional group of the compounds represented by the letters:

2.3.1 **C** (2)

2.3.2 **D** (2)

2.4 Consider the structural formula of compound **B**.

2.4.1 Give the IUPAC name of compound **B**. (2)

2.4.2 Draw the structural formula of the positional isomer of compound **B**. (2)

2.5 Compound **A** is a monomer that can be used to form a polymer.

2.5.1 Define the term *polymer*. (2)

2.5.2 Draw the structural formula of the polymer that can be formed from monomer **A**. (2)

2.5.3 Give the NAME of the polymer that can be formed from monomer **A**. (2)

[18]

QUESTION 3 (Start on a new page.)

A group of learners conducted an investigation in order to find the relationship between the boiling points and the chain lengths of three alkanes. The results of the investigation are shown in the table below.

	COMPOUND	BOILING POINT (°C)
A	C_2H_6	- 89
B	C_3H_8	- 42
C	C_4H_{10}	- 0,5

3.1 For this investigation, write down the following:

3.1.1 Investigative question (2)

3.1.2 Independent variable (1)

3.1.3 Dependent variable (1)

3.1.4 Controlled variable (1)

3.2 Before conducting the investigation, learners wrote down the following hypothesis:

The weaker the intermolecular forces, the higher the boiling point.

3.2.1 Write down the NAME of the intermolecular forces referred to in the hyphothesis. (1)

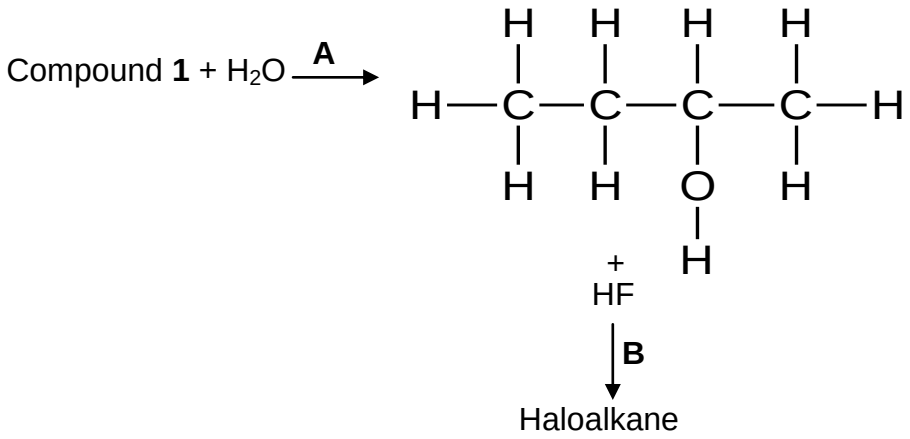
3.2.2 Is their hyphothesis CORRECT or INCORRECT? Write down only CORRECT or INCORRECT. (1)

3.2.3 Explain the answer to QUESTION 3.2.2. Refer to the chain length, the strength of the intermolecular forces and boiling point. (3)

3.2.4 Use the data in the table to write down a conclusion for the investigation. (2)
[12]

QUESTION 4 (Start on a new page.)

The flow diagram below shows how Compound **1**, an alkene, can be converted into a haloalkane through various organic reactions. Letters **A** and **B** represent different types of reactions.



4.1 Write down the TYPE of reaction represented by:

4.1.1 **A** (1)

4.1.2 **B** (1)

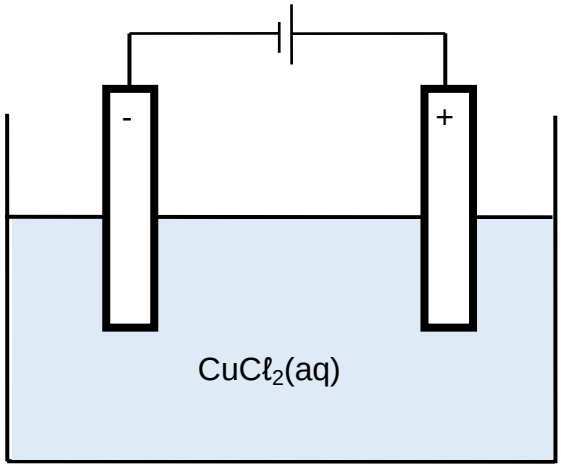
4.2 Draw the structural formula of Compound **1** and also give its IUPAC name. (4)

4.3 Write down a balanced chemical reaction using structural formulae to represent reaction **B**. (3)

4.4 Give TWO reaction conditions for reaction **A**. (2)
[11]

QUESTION 5 (Start on a new page.)

The diagram below represents an electrolytic cell used in the decomposition of a copper (II) chloride solution. The electrodes used are inert.



5.1 Define the following terms:

5.1.1 Anode (2)

5.1.2 Electrolysis (2)

5.2 Write down:

5.2.1 A balanced half-reaction that occurs at the anode (2)

5.2.2 The NAME of a half-reaction that occurs at the cathode (1)

5.3 Write down the NAME or FORMULA of:

5.3.1 An oxidising agent (1)

5.3.2 A reducing agent (1)

5.4 During the reaction in the above cell, bubbles were observed on one of the electrodes. Give the NAME of the chemical substance causing the bubbles. (1)
[10]

QUESTION 6 (Start on a new page.)

6.1 The cell notation below represents an electrochemical cell:

Cu/Cu^{2+} (1 mol·dm^{-3}) // Ag^{+} (1 mol·dm^{-3}) / Ag 298 K/25 °C

6.1.1 What energy conversion is taking place in the above cell? (2)

6.1.2 Write down TWO indicators from the cell notation that prove that the cell is operating under standard conditions. (2)

6.2 Write down a balanced half-reaction that occurs at the:

6.2.1 Cathode (2)

6.2.2 Anode (2)

6.3 Use calculations to conclude whether the reaction is SPONTANEOUS or NON-SPONTANEOUS. (5)

6.4 Give a reason for the answer to QUESTION 6.3. (1)
[14]

TOTAL: 75

DATA FOR TECHNICAL SCIENCES GRADE 12
PAPER 2
GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
VRAESTEL 2

TABLE 1/*TABEL 1*: PHYSICAL CONSTANTS/*FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	$p^{\ominus}$	$1{,}01 \times 10^5$ Pa
Standard temperature *Standaardtemperatuur*	$T^{\ominus}$	273 K/0 °C

TABLE 2/*TABEL 2*: FORMULAE/*FORMULES*

Emf/*Emk*	$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2.0 B 11	2.5 C 12	3.0 N 14	3.5 O 16	4.0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1.5 Aℓ 27	1.8 Si 28	2.1 P 31	2.5 S 32	3.0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1.5 Ti 48	1,6 V 51	1,6 Cr 52	1.5 Mn 55	1.8 Fe 56	1,8 Co 59	1.8 Ni 59	1.9 Cu 63,5	1.6 Zn 65	1.6 Ga 70	1.8 Ge 73	2.0 As 75	2.4 Se 79	2.8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1.4 Zr 91	41 Nb 92	1,8 Mo 96	1.9 Tc	2.2 Ru 101	2.2 Rh 103	2.2 Pd 106	1.9 Ag 108	1.7 Cd 112	1.7 In 115	1.8 Sn 119	1.9 Sb 122	2.1 Te 128	2.5 I 127	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	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	1.8 Tℓ 204	1.8 Pb 207	1.9 Bi 209	2.0 Po	2.5 At	86 Rn
0,7 Fr 87	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

KEY

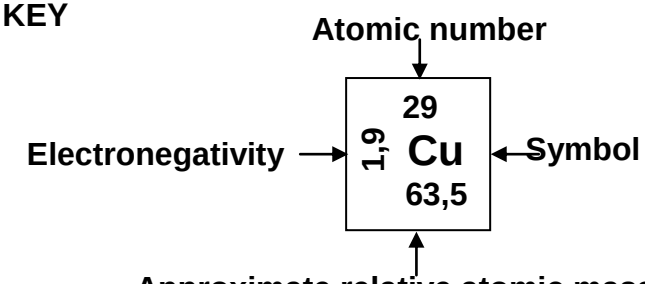


TABLE 4A: STANDARD REDUCTION POTENTIALS

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

Increasing oxidising ability ↑

Increasing reducing ability ↓

TABLE 4B: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability ↓

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

Increasing reducing ability ↑