



Province of the
EASTERN CAPE
EDUCATION

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NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2024

TECHNICAL SCIENCES P2

MARKS: 75

TIME: 1 ½ hours



★ I T S C E 2 ★

This question paper consists of 12 pages, and 4 data sheets.

INSTRUCTIONS AND INFORMATION

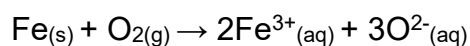
1. This question paper consists of FIVE questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. You may use a non-programmable calculator.
5. Leave a line open between subsections, i.e. QUESTION 2.1 and QUESTION 2.2.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
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 correct letter (A–D) next to the question numbers (1.1 to 1.5) in the ANSWER BOOK, for example 1.6 A.

- 1.1 The SI unit for mass of a substance is ...
- A gram.
 - B kilogram.
 - C joule per gram.
 - D joule per kilogram. (2)
- 1.2 In an OPEN system ... is/are exchanged between the system and the surrounding.
- A neither matter nor energy
 - B matter and energy
 - C only energy
 - D only matter (2)
- 1.3 The thermodynamic variables are ...
- A pressure, heat energy and internal energy.
 - B pressure, volume and heat energy.
 - C temperature, pressure and internal energy.
 - D temperature, pressure and volume. (2)

1.4 The reaction between iron and oxygen is represented by the following equation:



Which ONE of the following statements is CORRECT regarding the equation above?

- A Iron is the oxidising agent
- B Iron ion is the reducing agent
- C Oxygen is the oxidising agent
- D Oxygen ion is the reducing agent (2)

1.5 Consider the following statements:

An electrolyte conducts electricity because it ...

- (i) is a solution.
- (ii) is in a solid phase.
- (iii) contains cations and anions that are free to move.

Which ONE of the following combinations is CORRECT?

- A (i) only
 - B (ii) only
 - C (ii) and (iii)
 - D (i) and (iii) (2)
- [10]

QUESTION 2 (Start on a new page.)

In thermodynamics, we deal with a process that involves heat, work and energy.

2.1 Define a *closed system*. (2)

2.2 370 kJ is converted to mechanical work from 620 kJ of heat energy supplied to a machine.

2.2.1 Define a *heat engine*. (2)

2.2.2 Calculate the change in internal energy of this machine. (3)

2.2.3 Give TWO common examples of heat engines in technology today. (2)

[9]

QUESTION 3 (Start on a new page)

- 3.1 State the *law of conservation of heat*. (2)
- 3.2 Differentiate between a *thermodynamic system* and a *surrounding*. (4)
- 3.3 Calculate the amount of heat transferred as 80 g of water heats up from 15 °C to 100 °C. (4)
- 3.4 Define *specific heat capacity*. (2)
- 3.5 A warm aluminium ball of mass 500 g at a temperature of 180 °C, is added to 750 g of water at a temperature of 20 °C. The highest temperature the water reaches is 40 °C.
- Calculate the specific heat capacity of aluminium. (7)
- 3.6 State THREE practical applications of heat capacity in technology. (3)
- [22]**

QUESTION 4 (Start on a new page)

Redox reactions happen because of a change in oxidation numbers, which is the result of the transfer of electrons from one element to another.

4.1 Define the terms:

4.1.1 *Oxidation* (2)

4.1.2 *Oxidising agent* (2)

4.2 Determine the oxidation numbers of the underlined substance of each of the following:

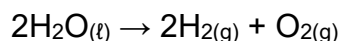
4.2.1 H₂ (2)

4.2.2 HCl (2)

4.2.3 H₂SO₄ (2)

4.2.4 NH₃ (2)

4.3 Consider the following balanced chemical reactions.

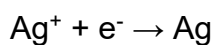
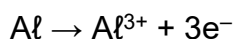


Identify the substance which is:

4.3.1 Oxidised (2)

4.3.2 Reduced (2)

4.4 Consider the following two half-reactions:

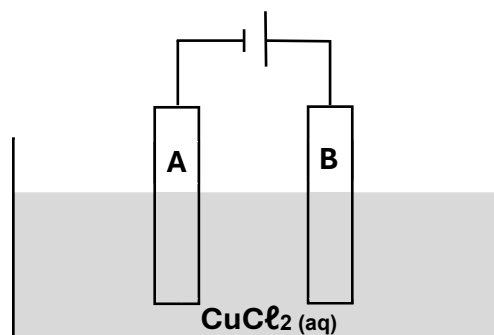


Write down the balanced reaction of these two half-reactions. (2)

[18]

QUESTION 5 (Start on a new page.)

Consider the electrochemical cell shown in the diagram below, used in a Grade 11 Technical Sciences practical to decompose copper(II)chloride using a carbon electrode.



- 5.1 State the energy conversion taking place in this cell. (2)
- 5.2 Differentiate between *electrolysis* and *electrolyte*. (4)
- 5.3 Which ONE of the electrodes is the cathode? (1)
- 5.4 Explain the answer to QUESTION 5.3 (2)
- 5.5 Define the term *reducing agent*. (2)
- 5.6 Write down the:
- 5.6.1 Half-reaction that takes place at the cathode (2)
- 5.6.2 Formula of the reducing agent in the above electrochemical cell (1)
- 5.6.3 Observation made at electrode **A** at the start of the reaction (2)
- [16]**

TOTAL: 75

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**DATA FOR TECHNICAL SCIENCES GRADE 11
PAPER 2**

**GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 11
VRAESTEL 2**

**TABLE 1: SPECIFIC HEAT CAPACITIES/
TABEL 1: SPESIFIEKE WARMTEKAPASITEIT**

NAME/NAAM	VALUES/WAARDES (J.kg ⁻¹ .K ⁻¹)
Water	4 200
Copper/Koper	400
Aluminium	900
Glass/Glas	700
Ethyl alcohol/Etielalkohol	2 460
Iron/Yster	460
Zinc/Sink	380
Lead/Lood	130
Ice/ys	2 100
Brass	380
Mercury/Kwik	140
Methylated spirits/Brandspiritus	2 400

**TABLE 2: HEAT AND THERMODYNAMICS
TABEL 2: HITTE EN TERMODINAMIKA**

$C = c m$	$Q = c m \Delta T$	$\Delta Q = \Delta U + \Delta W$
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TABLE 3: FORMULAE/TABEL 3: FORMULES

$$E^{\theta}_{\text{cell}} = E^{\theta}_{\text{cathode}} - E^{\theta}_{\text{anode}} / E^{\theta}_{\text{sel}} = E^{\theta}_{\text{katode}} - E^{\theta}_{\text{anode}}$$

$$E^{\theta}_{\text{cell}} = E^{\theta}_{\text{reduction}} - E^{\theta}_{\text{oxidation}} / E^{\theta}_{\text{sel}} = E^{\theta}_{\text{reduksie}} - E^{\theta}_{\text{oksidasie}}$$

$$E^{\theta}_{\text{cell}} = E^{\theta}_{\text{oxidising agent}} - E^{\theta}_{\text{reducing agent}} / E^{\theta}_{\text{sel}} = E^{\theta}_{\text{oksideermiddel}} - E^{\theta}_{\text{reduseermiddel}}$$

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

Half-reactions/Halfreaksies			E^{θ} (V)
$F_2(g) + 2e^-$	\rightleftharpoons	$2F^-$	+ 2,87
$Co^{3+} + e^-$	\rightleftharpoons	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	\rightleftharpoons	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	\rightleftharpoons	$Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^-$	\rightleftharpoons	$2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	\rightleftharpoons	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	\rightleftharpoons	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	\rightleftharpoons	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	\rightleftharpoons	Pt	+ 1,20
$Br_2(l) + 2e^-$	\rightleftharpoons	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	\rightleftharpoons	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	\rightleftharpoons	$Hg(l)$	+ 0,85
$Ag^+ + e^-$	\rightleftharpoons	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	\rightleftharpoons	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	\rightleftharpoons	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	\rightleftharpoons	H_2O_2	+ 0,68
$I_2 + 2e^-$	\rightleftharpoons	$2I^-$	+ 0,54
$Cu^+ + e^-$	\rightleftharpoons	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	\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	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	\rightleftharpoons	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	\rightleftharpoons	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	\rightleftharpoons	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	\rightleftharpoons	$H_2(g)$	0,00
$Fe^{3+} + 3e^-$	\rightleftharpoons	Fe	- 0,06
$Pb^{2+} + 2e^-$	\rightleftharpoons	Pb	- 0,13
$Sn^{2+} + 2e^-$	\rightleftharpoons	Sn	- 0,14
$Ni^{2+} + 2e^-$	\rightleftharpoons	Ni	- 0,27
$Co^{2+} + 2e^-$	\rightleftharpoons	Co	- 0,28
$Cd^{2+} + 2e^-$	\rightleftharpoons	Cd	- 0,40
$Cr^{3+} + e^-$	\rightleftharpoons	Cr^{2+}	- 0,41
$Fe^{2+} + 2e^-$	\rightleftharpoons	Fe	- 0,44
$Cr^{3+} + 3e^-$	\rightleftharpoons	Cr	- 0,74
$Zn^{2+} + 2e^-$	\rightleftharpoons	Zn	- 0,76
$2H_2O + 2e^-$	\rightleftharpoons	$H_2(g) + 2OH^-$	- 0,83
$Cr^{2+} + 2e^-$	\rightleftharpoons	Cr	- 0,91
$Mn^{2+} + 2e^-$	\rightleftharpoons	Mn	- 1,18
$Al^{3+} + 3e^-$	\rightleftharpoons	Al	- 1,66
$Mg^{2+} + 2e^-$	\rightleftharpoons	Mg	- 2,36
$Na^+ + e^-$	\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

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë

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

Half-reactions/Halfreaksies			E^{θ} (V)
$\text{Li}^{+} + \text{e}^{-}$	\rightleftharpoons	Li	-3,05
$\text{K}^{+} + \text{e}^{-}$	\rightleftharpoons	K	-2,93
$\text{Cs}^{+} + \text{e}^{-}$	\rightleftharpoons	Cs	-2,92
$\text{Ba}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Ba	-2,90
$\text{Sr}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Sr	-2,89
$\text{Ca}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Ca	-2,87
$\text{Na}^{+} + \text{e}^{-}$	\rightleftharpoons	Na	-2,71
$\text{Mg}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Mg	-2,36
$\text{Al}^{3+} + 3\text{e}^{-}$	\rightleftharpoons	Al	-1,66
$\text{Mn}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Mn	-1,18
$\text{Cr}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Cr	-0,91
$2\text{H}_2\text{O} + 2\text{e}^{-}$	\rightleftharpoons	$\text{H}_2(\text{g}) + 2\text{OH}^{-}$	-0,83
$\text{Zn}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Zn	-0,76
$\text{Cr}^{3+} + 3\text{e}^{-}$	\rightleftharpoons	Cr	-0,74
$\text{Fe}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Fe	-0,44
$\text{Cr}^{3+} + \text{e}^{-}$	\rightleftharpoons	Cr^{2+}	-0,41
$\text{Cd}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Cd	-0,40
$\text{Co}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Co	-0,28
$\text{Ni}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Ni	-0,27
$\text{Sn}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Sn	-0,14
$\text{Pb}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Pb	-0,13
$\text{Fe}^{3+} + 3\text{e}^{-}$	\rightleftharpoons	Fe	-0,06
$2\text{H}^{+} + 2\text{e}^{-}$	\rightleftharpoons	$\text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^{+} + 2\text{e}^{-}$	\rightleftharpoons	$\text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2\text{e}^{-}$	\rightleftharpoons	Sn^{2+}	+0,15
$\text{Cu}^{2+} + \text{e}^{-}$	\rightleftharpoons	Cu^{+}	+0,16
$\text{SO}_4^{2-} + 4\text{H}^{+} + 2\text{e}^{-}$	\rightleftharpoons	$\text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Cu	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^{-}$	\rightleftharpoons	4OH^{-}	+0,40
$\text{SO}_2 + 4\text{H}^{+} + 4\text{e}^{-}$	\rightleftharpoons	$\text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^{+} + \text{e}^{-}$	\rightleftharpoons	Cu	+0,52
$\text{I}_2 + 2\text{e}^{-}$	\rightleftharpoons	2I^{-}	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^{+} + 2\text{e}^{-}$	\rightleftharpoons	H_2O_2	+0,68
$\text{Fe}^{3+} + \text{e}^{-}$	\rightleftharpoons	Fe^{2+}	+0,77
$\text{NO}_3^{-} + 2\text{H}^{+} + \text{e}^{-}$	\rightleftharpoons	$\text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^{+} + \text{e}^{-}$	\rightleftharpoons	Ag	+0,80
$\text{Hg}_2^{2+} + 2\text{e}^{-}$	\rightleftharpoons	$\text{Hg}(\ell)$	+0,85
$\text{NO}_3^{-} + 4\text{H}^{+} + 3\text{e}^{-}$	\rightleftharpoons	$\text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\ell) + 2\text{e}^{-}$	\rightleftharpoons	2Br^{-}	+1,07
$\text{Pt}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Pt	+1,20
$\text{MnO}_2 + 4\text{H}^{+} + 2\text{e}^{-}$	\rightleftharpoons	$\text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^{+} + 4\text{e}^{-}$	\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	2Cl^{-}	+1,36
$\text{MnO}_4^{-} + 8\text{H}^{+} + 5\text{e}^{-}$	\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
$\text{Co}^{3+} + \text{e}^{-}$	\rightleftharpoons	Co^{2+}	+1,81
$\text{F}_2(\text{g}) + 2\text{e}^{-}$	\rightleftharpoons	2F^{-}	+2,87

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë

