education

Department of Education
FREE STATE PROVINCE

EXAMINATION

GRADE 11

PHYSICAL SCIENCES (PAPER 2: CHEMISTRY)

NOVEMBER 2022

MARKS: 100

TIME: 2 HOURS

This paper consists of 10 pages and two data sheets.
Please note that half-reaction tables are not included.
The electrochemistry questions can be answered without it.

INSTRUCTIONS AND INFORMATION

1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of EIGHT questions. Answer ALL 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 sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable pocket calculator.

7. You may use appropriate mathematical instruments.

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

9. Show ALL formulae and substitutions in ALL calculations.

10. Round off your FINAL numerical answers to a minimum of TWO decimal places where applicable.

11. Give brief motivations, discussions, et cetera where required.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write down only the letter A, B, C or D next to the question number (1.1–1.10) in your ANSWER BOOK.

1.1 Which one of the following compounds contains both ionic and covalent bonds?

A $MgC\ell_2$

B H_2O

C $CH_3C\ell$

D $NH_4C\ell$ (2)

1.2 The intermolecular forces between NH_3 molecules in the liquid phase can be classified as ... forces.

A Van der Waals

B dipole-dipole

C ion-dipole

D London (2)

1.3 The volume of a fixed mass of a gas is reduced without a change in temperature. The gas pressure increases because ...

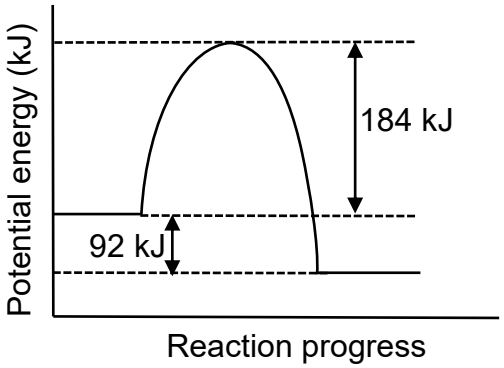
A the gas particles are now moving faster.

B the gas particles have increased in number.

C there is a greater distance separating the gas particles.

D a greater number of collisions per unit time now occurs against the container walls. (2)

1.4 The diagram illustrates the change in the potential energy of the reaction:



$$X_2 + 3Y_2 \rightarrow 2XY_3$$

How much is the ΔH PER MOLE of the XY_3 that is formed?

A -46 kJ·mol^{-1}

B -92 kJ·mol^{-1}

C +92 kJ·mol^{-1}

D +46 kJ·mol^{-1} (2)

1.5 Two different gases are kept under standard conditions of temperature and pressure (STP). If the two gases occupy the same volume, then they have the same ...

A mass.

B atomic mass.

C atomic number.

D number of molecules. (2)

1.6 x gram of Mg reacts with 2x gram of HCℓ according to the following balanced equation:

$$Mg + 2HC\ell \rightarrow MgC\ell_2 + H_2$$

Which one of the following statements is correct?

A x gram of H_2 is formed.

B 2x gram of $MgC\ell_2$ is formed.

C Mg is the limiting reagent.

D HCℓ is the limiting reagent. (2)

1.7 What does **Y** represent in the equation $H_2CO_3 + OH^- \leftrightharpoons H_2O + \mathbf{Y}$?

A An acid with the formula CO_3^{2-}.

B A base with the formula CO_3^{2-}.

C An acid with the formula HCO_3^-.

D A base with the formula HCO_3^-. (2)

1.8 The reaction below represents an acid-base reaction:

$$CH_3COOH + NH_3 \leftrightharpoons CH_3COO^- + NH_4^+$$

Which one of the following represents a conjugate acid-base pair in the reaction?

A NH_3 and CH_3COO^-

B CH_3COOH and CH_3COO^-

C NH_3 and CH_3COOH

D NH_4^+ and CH_3COO^- (2)

1.9 What is the oxidation number of Cu in $CuSO_4$?

A +4

B +2

C -2

D -4 (2)

1.10 The following equation represents a redox reaction:

$$Fe^{3+}(aq) + Cu(s) \rightarrow Fe^{2+}(aq) + Cu^+(aq)$$

Identify the reducing agent in this reaction.

A Fe^{2+}

B Cu^+

C Cu

D Fe^{3+} (2)

[20]

QUESTION 2

2.1 CO_2 is a molecule.

2.1.1 Define the term *molecule*. (2)

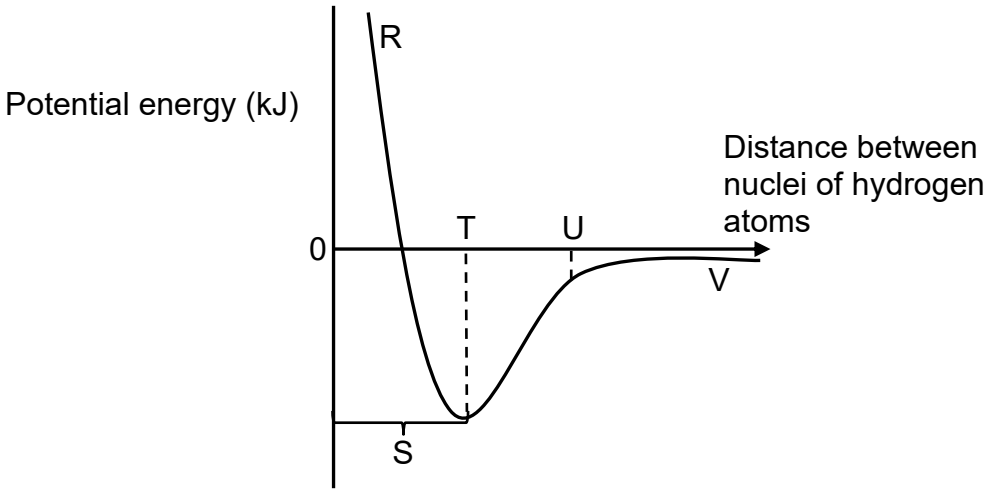
2.1.2 Draw a Lewis structure of this molecule. (2)

2.1.3 What is its molecular shape? (1)

2.1.4 Calculate the difference in electronegativity for carbon and oxygen. (1)

2.1.5 Is the CO_2 molecule POLAR or NON-POLAR? (1)

2.2 The graph shows the changes in the potential energy as a function of the distance between the nuclei of two hydrogen atoms during the formation of an H_2 molecule.



2.2.1 Give the name of the physical quantity represented by the letter **S**. (1)

2.2.2 Which letter represents the formation of the most stable hydrogen molecule? (1)

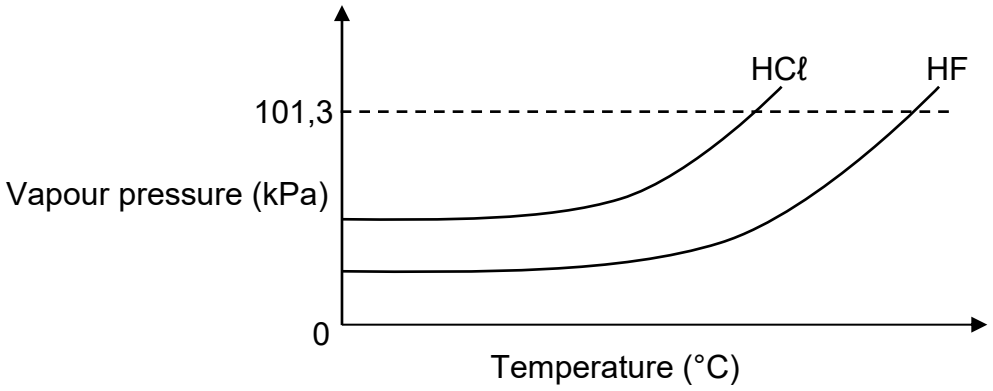
2.2.3 Is the bond formation exothermic or endothermic? Give a reason for your answer. (2)

2.2.4 How does the potential energy change from **T** to **S**? Choose from INCREASES, DECREASES or REMAIN THE SAME. Give a reason for your answer. (2)

[13]

QUESTION 3

3.1 The graph below shows the VAPOUR PRESSURE of HCℓ and HF at different temperatures.

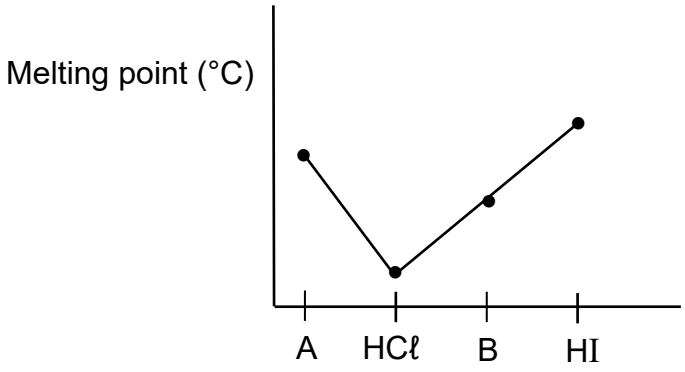


3.1.1 Define the term *vapour pressure*. (2)

3.1.2 Which compound, HCℓ or HF, has the higher boiling point? (1)

3.1.3 Explain the difference in vapour pressure between HCℓ and HF. (4)

3.2 The graph below, NOT DRAWN TO SCALE, shows the melting points of different hydrogen halides.



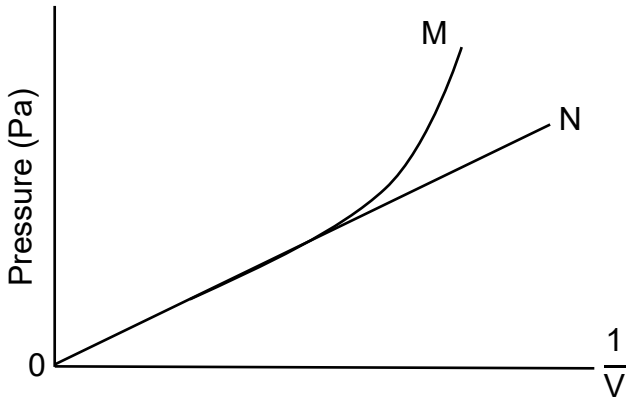
3.2.1 Define the term *melting point*. (2)

3.2.2 Which letter, **A** or **B**, represents HBr? (1)

3.2.3 Explain the difference in the melting points of HCℓ and HI. (3)
[13]

QUESTION 4

The graph on the right shows the behaviour of an ideal gas and a real gas at different pressures.



4.1 Write down THREE properties of an ideal gas. (3)

4.2 Under what conditions will a real gas behave LIKE an ideal gas? (2)

4.3 Which graph, **M** or **N**, represents a REAL gas? (1)

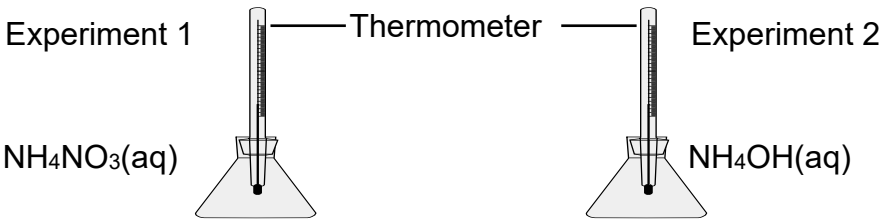
4.4 Fully explain your answer to QUESTION 4.3 by referring to pressure only. (3)

4.5 What conclusion can be drawn about the relationship between pressure and volume for the IDEAL gas? GIVE YOUR ANSWER WITH THE HELP OF SYMBOLS. (2)

[11]

QUESTION 5

5.1 A group of learners dissolved two different compounds in water to classify the reactions as exothermic or endothermic. They used the apparatus below and observed differences in the thermometer readings.



In experiment **1**, the temperature DROPPED, while in experiment **2**, the temperature ROSE.

5.1.1 Consider the above-mentioned information and write down the:

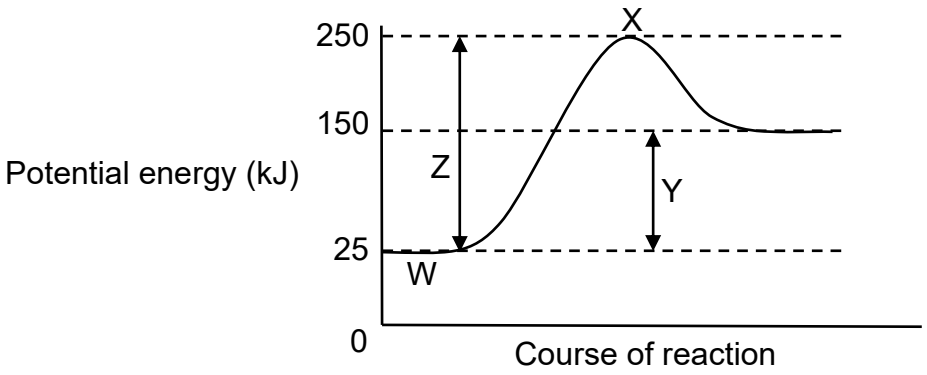
(a) Independent variable (1)

(b) Dependent variable (1)

(c) Controlled variable (1)

5.1.2 Which experiment, **1** or **2**, represents an endothermic reaction? Give a reason for your answer by referring to ENERGY. (2)

5.2 The graph of potential energy versus the course of the reaction for a certain chemical reaction is shown below.



5.2.1 Write down the letter that represents each of the following:

(a) Activation energy (1)

(b) ΔH (1)

5.2.2 Calculate the activation energy. (2)

[9]

QUESTION 6

25 g of an IMPURE sample of calcium carbonate, $CaCO_3$, reacts with EXCESS hydrochloric acid, HCℓ, of concentration of 1,5 mol·dm^{-3}. The balanced equation for the reaction is:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

6.1 State *Avogadro's law* in words. (2)

6.2 Which substance is the limiting reagent? (1)

6.3 The percentage purity of the $CaCO_3$ is 83%.

Calculate the VOLUME of CO_2 that is produced if the MOLAR gas volume is 24 000 cm^3. (6)

6.4 How will the volume you have calculated in question 6.3 change if 25 g of PURE $CaCO_3$ is used? Write only INCREASES, DECREASES or REMAINS THE SAME. (1)

[10]

QUESTION 7

7.1 An organic acid consists of the following percentage composition:

- 39,9% carbon
- 6,7% hydrogen
- 53,4% oxygen

7.1.1 Define the term *empirical formula*. (1)

7.1.2 Determine the molecular formula of the organic acid if the molar mass of the acid is 60 $g \cdot mol^{-1}$. (5)

7.2 An unknown salt, XNO_3 with a mass of 34 g, reacts completely with a $MgC\ell_2$ solution. The volume of the $MgC\ell_2$ solution is 250 cm^3 and its concentration is 0,4 $mol \cdot dm^{-3}$. They react according to the following balanced equation:

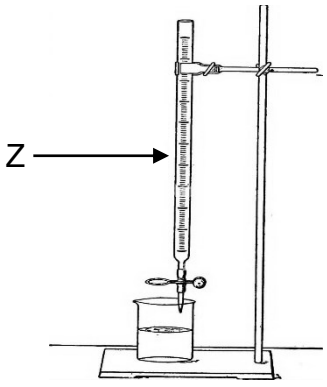
$$MgC\ell_2 + 2XNO_3 \rightarrow 2XC\ell + Mg(NO_3)_2$$

Determine, by means of calculations, which metal is represented by **X**. (6)
[12]

QUESTION 8

A group of learners want to determine the MASS of sodium hydroxide (NaOH) that is needed to neutralise 50 cm^3 of a sulphuric acid solution (H_2SO_4) with a concentration of 2 $mol \cdot dm^{-3}$.

They use the apparatus shown on the right to do a titration between the two solutions.



8.1 Write down the name of item **Z** in the diagram. (1)

8.2 What is the colour of bromothymol blue in a solution of:

8.2.1 Sulphuric acid (1)

8.2.2 Sodium hydroxide (1)

8.3 12,5 cm^3 of the NaOH(aq) is needed to neutralise the H_2SO_4(aq).

8.3.1 Write down a balanced chemical equation for this titration. (3)

8.3.2 Calculate the MASS of NaOH needed. (6)
[12]

GRAND TOTAL: 100

DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
VRAESTEL 2 (CHEMIE)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ 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*

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$		
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$	$n = \frac{V}{V_m}$
$c = \frac{n}{V}$	OR/*OF*	$c = \frac{m}{MV}$