LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

WATERBERG DISTRIC

PHYSICAL SCIENCE

GRADE 11

CONTROL TEST 3

18 SEPTEMBER 2023

TIME: 2 hours **MARKS: 100**

This paper consists of 11 pages and a formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME in the appropriate space 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.

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 calculator.

7. You may use appropriate mathematical instruments.

8. Show ALL formulae and substitutions in ALL calculations.

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

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

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

12. Write neatly and legibly.

Question 1

1.1 0,6 g magnesium reacts with an excess of sulphuric acid in the following reaction:

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

The volume hydrogens gas (in dm^3) produced at STP is…

A 0,56
B 22,4
C 24,00
D 553,09 (2)

1.2 Which ONE of the following statements regarding a chemical reaction is CORRECT?
The actual yield produced by a chemical reaction is usually …

A greater than the percentage yield.
B equal to the percentage yield.
C smaller than the theoretical yield.
D greater than the theoretical yield.
(2)

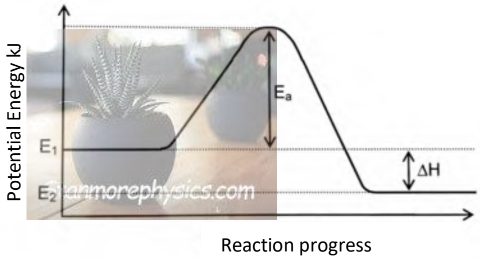
1.3 The following reaction shows the decomposition of ozone to oxygen:

$$2O_3(g) \rightarrow 3O_2$$

When the reaction progresses, the right side will form product, that when compared to the left side will have…

A more mole molecules, but less molecules.
B less mole molecules and all so less molecules.
C less mole molecules, but more molecules.
D more mole molecules and all so more molecules. (2)

1.4 A certain chemical reaction is represented by the following potential energy diagram.



Which ONE of the following variables will change when a catalyst is added?

A E_2
B E_1
C E_A
D ΔH (2)

1.5 The following chemical equation represents the formation of the hydronium ion:

$$H^+(aq) + H_2O(\ell) \rightarrow H_3O^+(aq)$$

In this reaction, water acts like a Lowry-Bronsted-base because it …

A gains protons
B donates protons
C gains electrons
D donates electrons (2)

1.6 Consider the following incomplete chemical equation below.

$$\mathbf{X} + 2HNO_3 \rightarrow Zn(NO_3)_2 + H_2O + CO_2$$

Which ONE of the following represents **X** in the equation above?

A $ZnCO_3$
B $ZnHCO_3$
C $ZnCO_2$
D $Zn(OH)_2$ (2)

1.7 At which one of the following conditions will the behaviour of oxygen be the nearest to that of the ideal gas?

A At low temperature and low pressure
B At high temperature and low pressure
C At low temperature and high pressure
D At high temperature and high pressure (2)

1.8 Which ONE of the following is the best representation of the relationship known as Boyle's law?

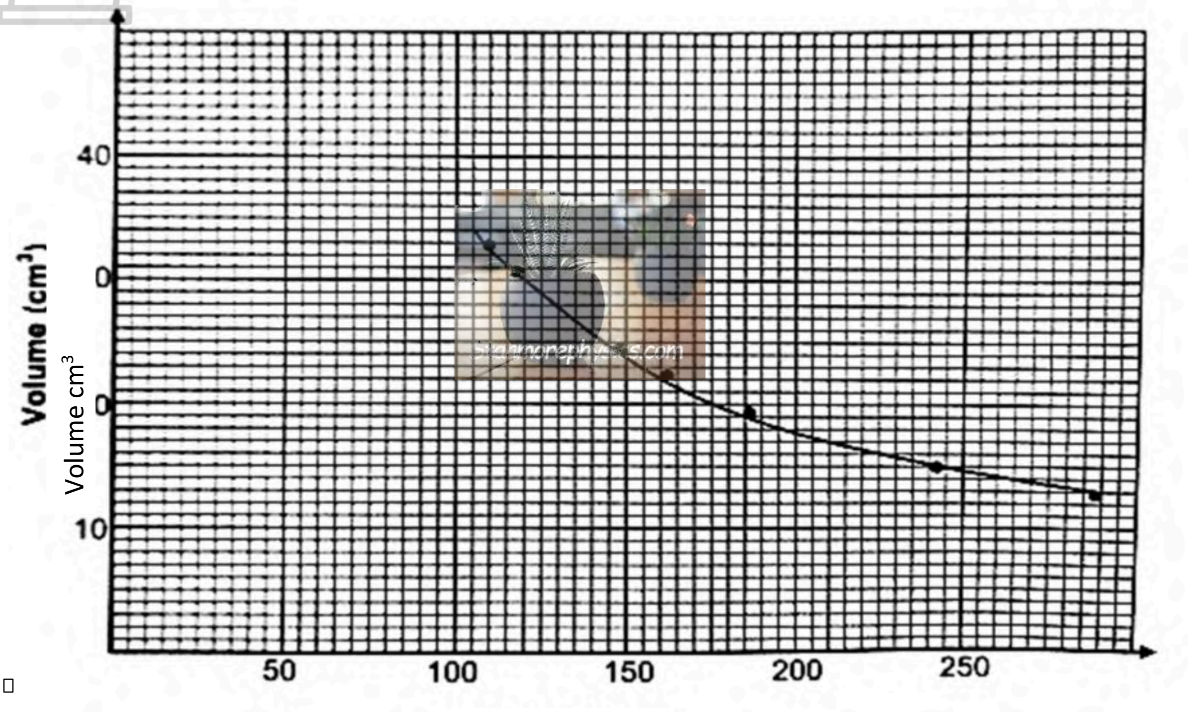
A $\frac{pV}{T} = nR$
B $\frac{p_1}{p_2} = \frac{V_2}{V_1}$ (at constant temperature)
C $\frac{p_1}{p_2} = \frac{V_1}{V_2}$ (at constant temperature)
D $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (at constant pressure) (2)

[16]

Question 2

A fixed mass of oxygen was used to verify one of the gas laws. The results obtained is shown in the graph below.

GRAPH OF VOLUME AGAINST PRESSURE



Pressure kPa

2.1 Write down …

2.1.1 the mathematical expression, in symbols, for the relationship between the variables as shown in the graph. (1)

2.1.2 The name of the gas law that was investigated. (1)

2.1.3 Formulate in words the gas law represented in the graph. (3)

2.2 Explain the relationship in QUESTION 2.1.1 in terms of the kinetic theory of gases. (2)

2.3 Write down TWO variables that must be controlled during this investigation and explain how it should be done. (4)

2.4 From the graph, write down the volume oxygen in cm^3, when the pressure is 120 kPa. (2)

2.5 Calculate the pressure, in kPa, exerted on the gas when it is compressed to 5 cm^3. (4)

2.6 Write down TWO conditions where the behaviour of oxygen deviates from that of the ideal gases. (2)

[19]

Question 3

Use the following reaction equation to answer the questions that follow.

$$SO_2 + O_2 \rightarrow SO_3$$

3.1 Balance the equation through simple inspection. (2)

3.2 How many moles of SO_3 will form if 3 moles of SO_2 react with sufficient O_2? (2)

3.3 How many moles of SO_3 will form if 3 moles of SO_2 react with 3 moles of O_2? (2)

3.4 Calculate the mass of SO_3 that forms when 160 g SO_2 react with sufficient O_2. (3)

3.5 Calculate the mass of SO_3 that forms when 160 g SO_2 react with 160g O_2. (5)

3.6 Determine if it's possible to produce 80 g of SO_3 when only 20 g of O_2 reacts with sufficient SO_2. (3)

3.7 Ammonium nitrate (NH_4NO_3) and nitro glycerine ($C_3H_5(NO_3)_3$) are used as explosives.

The following balanced equations for the decomposition of these substances are shown:

$$2NH_4NO_3(s) \rightarrow 2N_2(g) + 4H_2O(g) + O_2(g) + \text{energy}$$

$$4C_3H_5(NO_3)_3 \rightarrow 12CO_2(g) + 10H_2O(g) + 6N_2(g) + O_2(g) + \text{energy}$$

3.7.1 What is common between the products formed in both these reactions? (1)

3.7.2 Explain why these substances are effective explosives. (3)

3.7.3 Calculate the total volume Nitrogen gas released when 500 g of NH_4NO_3 decomposes at STP. (4)

[25]

Question 4

The chemical reaction for the preparation of the medicine, aspirin, from two compounds **X** and **Y,** is represented by the following equation below.

$$2C_7H_6O_3 + C_4H_6O_3 \rightarrow 2C_9H_8O_4 + H_2O$$
$$\text{X} \qquad\qquad \text{Y} \qquad\qquad \text{aspirin}$$

A chemist reacts 14 g of compound **X** with 10 g of compound **Y**.

4.1 Define the term *limiting reactant* in a chemical reaction. (2)

4.2 Complete the necessary calculation to determine which one of compound **X** or compound **Y** is the limiting reactant. (5)

The actual mass aspirin obtained, is 11,5 g.

4.3 Calculate the percentage yield of the aspirin. (5)

[12]

Question 5

Read the texts below and answer the questions that follow.

The bombarbier beetle

The bombardier beetle defends himself against his enemies by spraying them with a chemical spray. The beetle has two glands. One gland contains an aqueous solution of hydroquinone and hydrogen peroxide. The other gland contains a mixture of enzymes. When threatened, the blaster pushes fluid from its first gland into the other chamber. In the presence of the enzymes, a reaction takes place:

$C_6H_4(OH)_2(aq)$ + H_2O_2 → $C_6H_4O_2(aq)$ + $2H_2O(l)$ Eq. 1
Hydroquinone Quinone

The mixture becomes extremely hot and is spray on the attacker. Apart from the thermal effect, Quinone also acts as a "repellent" for other insects and animals.

5.1 Consider the steps below:

$C_6H_4(OH)_2(aq) \rightarrow C_6H_4O_2(aq) + H_2(g)$ ΔH = 177 kJ .... Eq II

$H_2O_2(aq) \rightarrow H_2O(\ell) + ½O_2(g)$ ΔH = –94,6 kJ .... Eq III

$H_2(g) + ½O_2(g) \rightarrow H_2O(\ell)$ ΔH = –286 kJ .... Eq IV

Equation I is obtained from adding equation II, III and IV. Show by means of calculations that the mixture ejected by the beetle is extremely hot. (3)

5.2 Sketch a potential energy graph for the reaction in equation I, indicate the necessary labels. (4)

5.3 Why should people be careful when they play with bombardier beetles? (2)

[9]

Question 6

The stomach secretes gastric juices which contain hydrochloric acid. The gastric juices promote digestion. Sometimes there is an overproduction of acid, which leads to heartburn or indigestion. Antacids, such as magnesia water can be used to neutralize the excess acid. Magnesia water is only slightly soluble in water and has the chemical formula $Mg(OH)_2$.

6.1 Write down a balanced chemical equation to indicate how the antacid reacts with acid. (3)

6.2 The instructions on the bottle recommend that children under the age of 12 drink one teaspoon of magnesia water, while adults can drink two teaspoons of antacid. Briefly explain why the doses are different. (2)

6.3 Why is it not recommended to take an overdose of antacid? Refer to the acid concentration in the stomach in your answer. (2)

6.4 Daleen examines the differences in the concentration of acid rain. On 10 different rainy days, she collected 50 ml of rainwater each time, added 3 drops of bromothymol blue solution to it and then measured with a medicine dropper how many droplets of a sodium hydroxide solution were needed to neutralize the acid solution. Her results are recorded in the following table:

Rain sample	1	2	3	4	5	6	7	8	9	10
Number of NaOH-drops	3	1	2	2	2	3	4	5	6	8

6.4.1 What was the colour of the acid rain when Daleen added the bromothymol blue indicator, but before she added the NaOH? (2)

6.4.2 Name three variables that Daleen had to keep constant to ensure that the investigation is a true version of the facts. (3)

6.4.3 Which rain sample had the highest concentration of acid rain? (2)

6.4.4 Give a reason for your answer to question 6.4.3. (2)

6.4.5 Give 3 negative effects that acid rain has on the environment. (3)

[19]

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	$6{,}02 \times 10^{23}\ mol^{-1}$
Molar gas constant *Molêre gaskonstante*	R	$8{,}31\ J \cdot K^{-1} \cdot mol^{-1}$
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^{5}\ Pa$
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4\ dm^{3} \cdot mol^{-1}$

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* $c=\frac{m}{MV}$

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PHYSICAL SCIENCE

GRADE 11

CONTROL TEST 2

MARKING GUIDELINES

MARKS: 100

This marking guidelines consist of 9 pages

QUESTION 1:		
1.1	A √√	(2)
1.2	C √√	(2)
1.3	D √√	(2)
1.4	C √√	(2)
1.5	A √√	(2)
1.6	A √√	(2)
1.7	B √√	(2)
1.8	B √√	(2)
		[16]

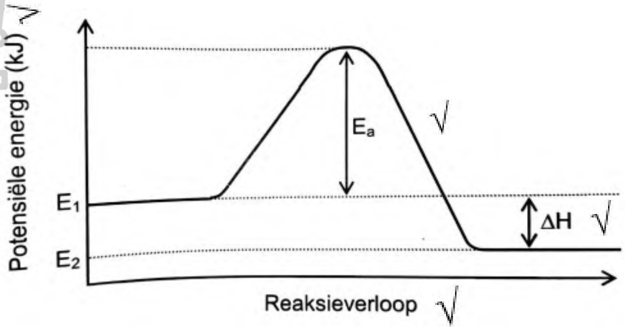
QUESTION 2:		
2.1.1	$V \propto \frac{1}{p}$ √ of $p \propto \frac{1}{V}$ √	(1)
2.1.2	Boyle's Law. √	(1)
2.1.3	**Boyle's law:** The pressure of an enclosed gas √ is inversely proportional to the volume √, given the temperature remains constant. √	(3)
2.2	When the **volume** of a gas container **decreases**, the area for collisions between the gas molecules and the sides of the container decreases -√ there for more collisions per unit area and unit time with the sides of the container, and **pressure increases.** √	(2)
2.3	The amount of oxygen gas used must remain constant- no gas must leak out or escape. √√ The temperature must remain constant – pressure must be increased in small amounts to reduce the increase in temperature. √√	(4)
2.4	30 cm^3√√	(2)
2.5	$p_1V_1=p_2V_2$√ (120 kPa)(30 cm^3) = p_2(5 cm^3) √ $p_2 = \frac{(120)(30)}{5}$ $p_2 = 720$√ kPa√	(4)
2.6	The behaviour deviates from that of an ideal gas at high pressure √ and low temperature. √	(2)
		[19]

QUESTION 3:		
3.1	$2SO_2 + O_2 \rightarrow 2SO_3$ √√	(2)
3.2	$SO_2 : SO_3$ 2:2 } √ 1:1 Thus 3 mole of SO_2 will form 3 mole of SO_3.√	(2)
3.3	Required: $SO_2 : O_2$ 2 : 1 Actual: $SO_2 : O_2$ 3 : 3 1 : 1√ SO_2 is limiting reactant: The same amount of mole SO_3 is formed in relation with the mole SO_2 used, and that is 3 mole. √	(2)
3.4	$n = \frac{m}{M}$ $= \frac{160}{64}$ = 2,5 mol $SO_2 : SO_3$ 2 : 2 √ 2,5 : x X= 2,5 mol SO_3 √ $n = \frac{m}{M}$ $2.5 = \frac{m}{80}$	

	= 200g SO_3 √	(3)
3.5	SO_2 $n = \frac{m}{M}$ $= \frac{160}{64}$ = 2,5 mol O_2 $n = \frac{m}{M}$ $= \frac{160}{32}$ = 5 mol √ SO_2:O_2 2:1 SO_2: $\frac{2.5}{2}$ √= 1.25 mol O_2 : $\frac{5}{1}$ = 5 mol 1.25< 5 √ SO_2 is limited. SO_2 : SO_3 2:2 } √ 1:1 } 2.5 : X 2.5 mol SO_3 $n = \frac{m}{M}$ $2.5 = \frac{m}{80}$ m= 200 g SO_3√	(5)
3.6	$n = \frac{m}{M}$ $= \frac{20}{32}$ = 0.625 mol O_2:SO_3	

	1:2 0.625:X X= 1.25 mol SO_3√ $n = \frac{m}{M}$ $1.25 = \frac{m}{80}$√ = 100 g 100 g > 80 g√	(3)
3.7.1	Al the products are gases Both reactions form N_2, H_2O and O_2 (any one√)	(1)
3.7.2	Explosives contain chemicals that burn and decompose to form heat and high volumes of gas – the high volume of gas is responsible for high pressure and that leads to an explosion. √√√	(3)
3.7.3	$n = \frac{m}{M}$ $= \frac{500}{80}$ = 6,25 mol √ 2 mole produced 7 mole of gases 2:7 6,25:X 7(6,25)=2X√ X= 21,875 mole gas formed $n = \frac{V}{Vm}$√ $21{,}875 = \frac{V}{22{,}4}$ V= 490 dm^3√	(4)
		[25]

QUESTION 4:		
4.1	The limiting reactant is the reactant that is used up completely during the chemical reaction √. That determines the amount of products that form. √	(2)
4.2	Vir X $n = \frac{m}{M}$√ $= \frac{14}{138}$ = 0,10 mol√ Vir Y $n = \frac{m}{M}$ $= \frac{10}{102}$ = 0,10 mol√ Mole ratio X:Y 2:1 Divides actual mole with mole ratio. √ X: 0.10 ÷ 2 = 0,05 Y: 0.10 ÷ 1= 0,10 0,05 < 0.10 X < Y X is the limiting reactant√	(5)
4.3	$C_7H_6O_3$ is the limiting reactant $C_7H_6O_3$: $C_9H_8O_4$ 2:2 0,10 : x 0,10 mole aspirin forms. $n = \frac{m}{M}$√ $0,10 = \frac{m}{180}$√ = 18 g actually forms√ % aspirin yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100$ $= \frac{11,5}{18} \times 100$√ = 63,89%√	(5)
		[12]

QUESTION 5		
5.1	$\Delta H = E_{absorbed} - E_{released}$ √ = 177 – (94,6 + 286) √ = - 203,6 kJ√ 203,6 kJ is released	(3)
5.2	 1 mark – If x axis is labelled correct 1 mark – If y axis is labelled correct 1 mark – For the shape of graph 1 mark – If E_a or ΔH is indicated	(4)
5.3	The mixture is exothermic, becomes warm√ and can be responsible for burning wounds. √	(2)
		[9]

QUESTION 6			
6.1	$2HC\ell + Mg(OH)_2$√ → $MgC\ell_2 + 2H_2O$√ √ Balance		(3)
6.2	The stomach of grownups produced more acid than that of children under the age of 12 there for grownups must use more antacid. √√		(2)
6.3	If you drink too much antacids, it can neutralise too much acids and acids are needed for healthy digestion. √√		(2)
6.4			
	6.4.1	Yellow. √√	(2)
	6.4.2	The amount of rain water must be precisely 50ml. √ The concentration NaOH must be the same. √ The same medicine drop must be use so that the drops are the same size. √ The colour must be the same after decolouration. √ (any 3)	(3)
	6.4.3	Rain sample 10	(2)
	6.4.4	Rain sample 10 needs the most drops of NaOH-solution to be neutralised and there for has the highest concentration acid rain. √√	(2)
	6.4.5	To the disadvantage of plants.√ Damage buildings. √ Change the pH of the soil.√	(3)
			[19]