LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

NATIONAL
SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES: CONTROL TEST 2

13 SEPTEMBER 2024

MARKS: 100

TIME: 2 hours

This question paper consists of 8 pages and 2 data sheets

INSTRUCTIONS AND INFORMATION

1. Write your name and class in the appropriate spaces on the ANSWER BOOK.
2. The question paper consists of 7 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 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, et cetera 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 correct answer and write only the letter (A – D) next to the question numbers (1.1 – 1.7) in the ANSWER BOOK, e.g. 1.8 E.

1.1 An activated complex is the …

A. Stable transition state from reactants to products.
B. Unstable transition state from reactants to products
C. Permanent, high – energy assemblage of molecules
D. Temporary, low – energy assemblage of molecules (2)

1.2 A change of x Kelvin is the same as ….

A. $(x + 273)\,℃$
B. $(273 - x)\,℃$
C. $(x + 273)\,℃$
D. $x\,℃$ (2)

1.3 The pressure in a party balloon of which the volume is V, is P. The party balloon is now squeezed to ONE – THIRD of its volume with no change in temperature.
The NEW pressure in the party balloon is …

A. P
B. $^1/_3$ P
C. 3 P
D. 6 P (2)

1.4 According to the Kinetic Theory, all the molecules of a gas at a given temperature ….

A. do not have the same speed
B. have the same direction of motion
C. have the same average kinetic energy
D. have the same momentum (2)

1.5 The SAME MASS of sodium hydroxide (NaOH) is dissolved in different volumes of water.

Which ONE of the following solutions has the HIGHEST concentration

A. 50 g NaOH dissolved in 1 dm^3 H_2O
B. 50 g NaOH dissolved in 200 cm^3 H_2O
C. 50 g NaOH dissolved in 400 cm^3 H_2O
D. 50 g NaOH dissolved in 3 dm^3 H_2O (2)

1.6 0,5 mol of ethane (C_2H_6) and 0,5 mol of magnesium (Mg):

(i) Have the same number of particles
(ii) Have the same mass
(iii) Have different masses

Which ONE of the following is CORRECT?

A. (i) only
B. (i) and (ii) only
C. (ii) and (iii) only
D. (i) and (iii) only (2)

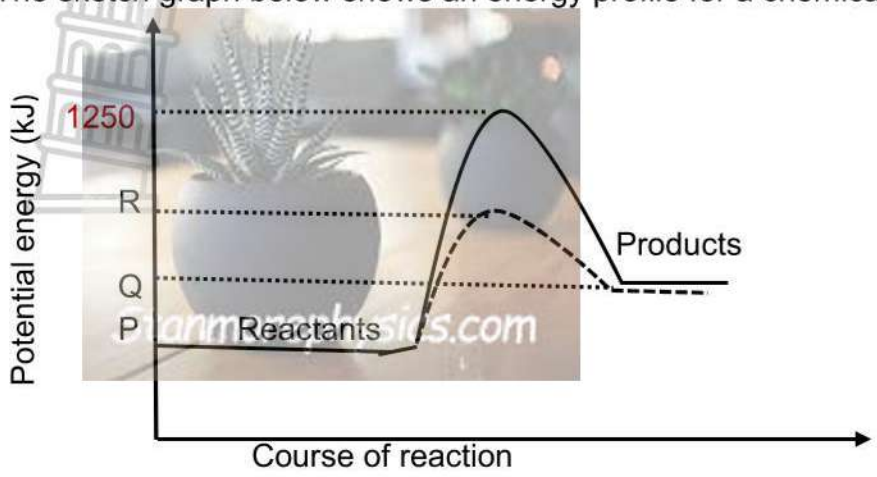
1.7 138 g of sodium contains TWICE as many atoms as …

A. 36 g of carbon
B. 32 g of oxygen gas
C. 48 g of magnesium
D. 80 g of calcium (2)

[14]

QUESTION 2

The sketch graph below shows an energy profile for a chemical reaction



2.1 Define the term *activation energy*. (2)

2.2 Is the reaction endothermic or exothermic?
Explain the answer with reference to the energy of the reactants and products. (2)

The following information is given:

- The activation energy without a catalyst is 800 kJ
- The activation energy with a catalyst is 490 kJ
- The energy released in the formation of products in the uncatalysed reaction is 520 kJ

2.3 Calculate the value of each of the following:

2.3.1 P (2)
2.3.2 R (2)
2.3.3 Δ H (2)

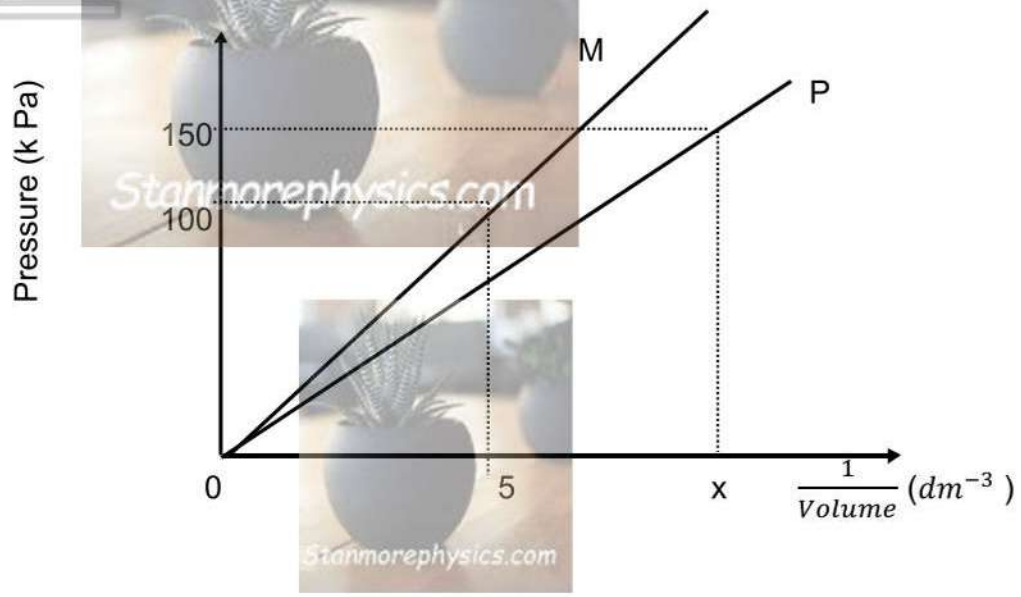
2.4 How does a catalyst affect each of the following?
State only INCREASES, DECREASES, OR STAYS CONSTANT

2.4.1 The heat of reaction (1)
2.4.2 Activation energy for the reaction (1)
2.4.3 Energy absorbed during the reaction (1)
[13]

QUESTION 3

An experiment is conducted to determine the relationship between the pressure and volume of an enclosed gas.

The results obtained are shown in the sketch graph below



3.1 State *Boyle's Law* in words (2)

3.2 For this investigation, write down the:

3.2.1 Dependent variable (1)
3.2.2 Independent variable (1)
3.2.3 TWO controlled variables (2)

3.3 Calculate the value of X, shown on the graph (4)

3.4 Which ONE of the graphs, M or P represents the results for the experiment that is conducted at a LOWER temperature?
Explain the answer (4)
[14]

QUESTION 4

4.1 A scientist determined that the gas pressure in the tyres of his/her car is 200 kPa, at a temperature of 20 ^{0}C. After a long journey the temperature of the gas inside the tyres increased to a maximum of 55 ^{0}C. The tyres allow for an expansion of 2,00 % for the trip.

4.1.1 Explain the term *temperature of a gas* (2)

4.1.2 Convert the following temperature values (in ^{0}C) to kelvin (K)

a) 20 ^{0}C (1)

b) 55 ^{0}C (1)

4.2 A certain gas expands by 25 cm^3 when the pressure is reduced from 500 kPa to 40 kPa.

4.2.1 Calculate the original volume of the gas if the temperature of the gas does not change. (6)

[10]

QUESTION 5

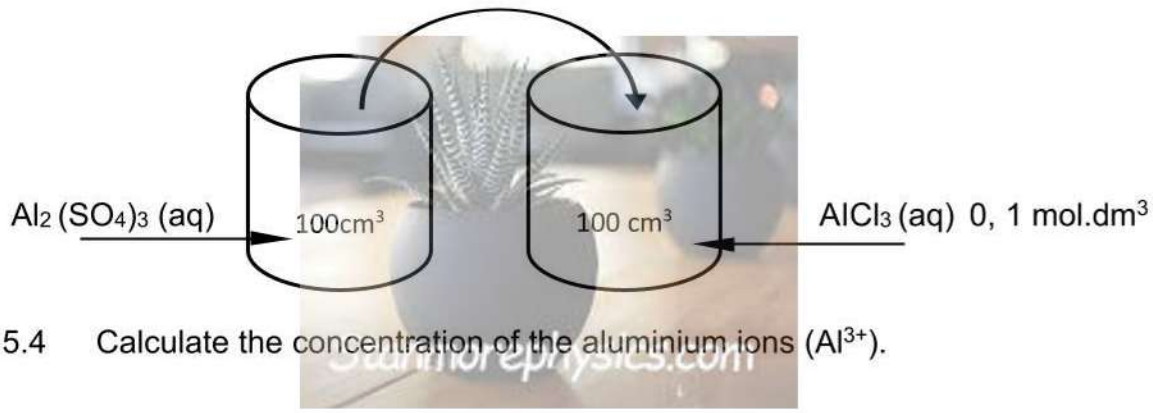
A solution of Aluminium sulphate [$Al_2(SO_4)_3$] is made up by dissolving 6,84 g of solid in sufficient water to make up 200 cm^3 of solution.

5.1 Define the term *concentration of a solution*. (2)

5.2 Calculate the concentration of the solution (in mol.dm^{-3}). (4)

5.3 Determine the concentration of the sulphate ions (SO_4^{-2}) in this solution. (2)

100 cm^3 of the solution of Aluminium Sulphate above is added to 100 cm^3 of $AlCl_3$ solution of concentration 0,1 mol.dm^{-3}, as shown in the diagram below.



5.4 Calculate the concentration of the aluminium ions (Al^{3+}). (6)

[14]

QUESTION 6

Acetic acid contains only carbon (C), hydrogen (H) and oxygen (O).
A 4,24 x 10^{-3} g sample of acetic acid is completely burned.
It gives 6,21 x 10^{-3} g of carbon dioxide (CO_2) and 2,54 x 10^{-3} g of water

Determine the:

6.1	Number of moles of carbon in CO_2 produced	(3)
6.2	Mass of carbon in CO_2 produced	(3)
6.3	Mass percentage of CO_2 produced	(2)
6.4	Mass of hydrogen in the H_2O produced	(6)
6.5	Mass percentage of hydrogen produced	(2)
6.6	Mass percentage of oxygen produced	(2)
6.7	Empirical formula of the acetic acid	(4)
6.8	Molecular formula of acetic acid if its molar mass is 60 g.mol^{-1}	(3)

[25]

QUESTION 7

The Ostwald process is an industrial process used to manufacture nitric acid. One of the stages in this process involves a reaction between ammonia gas and oxygen gas, as represented by the following reaction equations:

$$4\ NH_3(g) + 5\ O_2(g) \longrightarrow 4\ NO\ (g) + 6\ H_2O\ (l)$$

In one such reaction, 500 g of ammonia gas and 500 g of oxygen gas are mixed.

7.1 Which ONE, ammonia or oxygen, is the limiting reagent?
Justify the answer by means of appropriate calculations. (6)

The actual mass of NO(g) obtained is 210 g.

7.2 Calculate the percentage yield of NO(g). (4)

[10]

Total 100

DATA FOR PHYSICAL SCIENCES GRADE 11 PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	p^{θ}	$1,013 \times 10^5$ Pa
Molar gas volume at STP	Vm	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature	T^{θ}	273 K
Charge on electron	e^-	$-1,6 \times 10^{-19}$ C
Avogadro's constant	N_A	$6,02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE

$p_1V_1 = p_2V_2$	$pV = nRT$
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	

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 1 H 1																	2 He 4
1,0 3 Li 7	1,5 4 Be 9											2.0 5 B 11	2.5 6 C 12	3,0 7 N 14	3.5 8 O 16	4.0 9 F 19	10 Ne 20
0,9 11 Na 23	1,2 12 Mg 24											1.5 13 Al 27	1.8 14 Si 28	2.1 15 P 31	2.5 16 S 32	3.0 17 Cl 35,5	18 Ar 40
0,8 19 K 39	1,0 20 Ca 40	1,3 21 Sc 45	1,5 22 Ti 48	1,6 23 V 51	1,6 24 Cr 52	1.5 25 Mn 55	1.8 26 Fe 56	1.8 27 Co 59	1.8 28 Ni 59	1.9 29 Cu 63,5	1.6 30 Zn 65	1.6 31 Ga 70	1.8 32 Ge 73	2,0 33 As 75	2.4 34 Se 79	2.8 35 Br 80	36 Kr 84
0,8 37 Rb 86	1,0 38 Sr 88	1,2 39 Y 89	1,4 40 Zr 91	41 Nb 92	1,8 42 Mo 96	1.9 43 Tc	2.2 44 Ru 101	2.2 45 Rh 103	2.2 46 Pd 106	1.9 47 Ag 108	1.7 48 Cd 112	1.7 49 In 115	1.8 50 Sn 119	1.9 51 Sb 122	2.1 52 Te 128	2.5 53 I 127	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137	57 La 139	1,6 72 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 81 Tl 204	1.8 82 Pb 207	1.9 83 Bi 209	2.0 84 Po	2.5 85 At	86 Rn
0,7 87 Fr	0,9 88 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

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

29
Cu
1,9
63,5

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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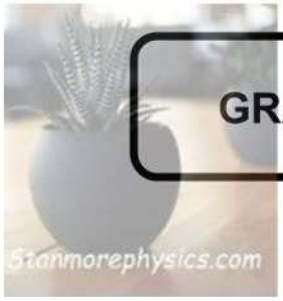

GRADE 11

PHYSICAL SCIENCES
CONTROLLED TEST 2 ERRATA
13 SEPTEMBER 2024

MARKS : 90

	QUESTION 1	
1.2	REMOVED, beyond scope	(-2)
	QUESTION 2	
2.32	Accept $\Delta H > 0$	
2.3.2	REPLACED Y WITH R Option 2 $E_A(catalysed) = E_{AC} - E_R$ $490 = R - 450$ ✓ $R = 940\ kJ$ ✓	(2)
2.3.3	Option 2 $\Delta H = Energy\ absorbed - Energy\ released$ $\Delta H = 800 - 520$ ✓ $280kJ$ ✓	(2)
	QUESTION 3	
3.2.2	Volume ✓ (Do not accept $\frac{1}{V}$)	(1)
3.2.3	**ACCEPT:** Numbers of moles of gas ✓OR number of gas molecules✓ in place of the mass	(1)
3.3	**REMOVE:** The gradient of the graph is PV, for each of the graphs PV is constant and is not the same. Coordinates of the graph M cannot be used to obtain answers on graph P	(-4)
3.4	**ACCEPT:** P✓ • If the temperature is low; the average kinetic energy will be low.✓ • The particles will move closer to each other and the intermolecular forces between the particles increase.✓ • When the energy of particles decrease significantly and the gas liquefies.✓	(4)
	QUESTION 4	
4.1.2	REMOVED, beyond scope	(-2)

4.2.1	**Marking criteria** • Formula ✓ • Subtitute P_1as 500 ✓ • Substitute P_2 **as** 40 ✓ • $\underline{V_1}$ + ✓25 ✓ • Final answer ✓	(6)
	QUESTION 5	
5.4	So, in $Al_2(SO_4)_3$: n = cV = (0,2)(0,1) √ =0.02×2 = 0.04mol In $AlCl_3$: n = cV = (0,1)(0,1) √ = 0,01 mol So, the total number of moles of Al^{3+} ions in the mixture : n_{total} = 0, 04 + 0, 01 √ = 0, 05 mol C = $\frac{n}{V}$ ✓ = $\frac{0.05}{0.2}$ ✓ = 0.25mol.dm^{-3}✓	
	QUESTION 6	
6.3	Removed	(-2)
6.5	Mass % H = $\frac{0.0002822222}{2\times10^{-3}}$ x 100 √ , = 14.11% √	(3)

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GRADE 11

PHYSICAL SCIENCES: CONTROL TEST 2
13 SEPTEMBER 2024
MARKING GUIDELINE

TOTAL: 100 MARKS

This marking guideline consists of 8 pages

QUESTION 1

1.1 B √√

1.2 D √√

1.3 C √√

1.4 C √√

1.5 B √√

1.6 D √√

1.7 A √√ **[14]**

QUESTION 2

2.1 The minimum energy needed for a reaction to take place. √√ (2)

2.2 Endothermic √
Energy of products is higher than that of the reactants or
Energy of the reactants is lower than that of the products √ (2)

2.3.1 1250 – P = 800 √
P = 450 (kJ) √ (2)

2.3.2 800 – 490 = 310 √
∴ Y = 1250 – 310
∴ Y = 940(kJ) √ (2)

2.3.3 Q = 1250 – 520
= 730 √

$\Delta H = \Delta H_p - \Delta H_R$
= 730 – 450
= 280 kJ √ (2)

2.4.1 Stays constant √ (1)

2.4.2 Decreases √ (1)

2.4.3 Decreases √ (1)

[13]

QUESTION 3

3.1 The pressure of an enclosed (mass of) gas is inversely proportional to the volume it occupies at constant temperature. √√ (2)

3.2.1 Pressure √ (1)

3.2.2 Volume √ (1)

3.2.3 Temperature √
(Enclosed) mass of gas √ (2)

3.3 $\frac{1}{V}$ = 5,0

V = 0,2 dm^3

$P_1V_1 = P_2V_2$ √

(100)(0,2) √ = (150) V_2 √

∴ V_2 = 0,13333 dm^3

∴ **x** = $\frac{1}{V}$

= $\frac{1}{0,13333}$

= 750 dm^3 √ (4)

3.4 **P** √

- Temperature is a measure of the average kinetic energy √
- pV is a measure of the energy contained and the gradient = pV √
- The gradient for graph P is smaller, which indicates that the temperature is lower. √ (4)

[14]

QUESTION 4

4.1.1 The average kinetic energy of the molecules of the gas √√ (2)

4.1.2 a) (20 + 273) K = 293 K √ (1)

b) (55 + 273) K = 328 K √ (1)

4.2.1 $P_1V_1 = P_2V_2$ ✓

500 (V_1) ✓ = 40 (V_1 + 25) ✓

$500V_1 = 40V_1 + 1\,000$ ✓

$460V_1$ ✓ = 1 000

$V_1 = 2{,}17\ cm^3$ ✓ (6)

[10]

QUESTION 5

5.1 The amount of solute per litre of solution √√

5.2

OPTION 1

$C = \frac{m}{MV}$ √

$= \frac{6{,}84\ √}{(342)(0{,}2)\ √}$

$= 0{,}10\ mol.dm^{-3}$√

OPTION 2

$n = \frac{m}{M}$

$= \frac{6{,}84}{342}$ √

= 0,02 mol

$c = \frac{n}{V}$ √

$= \frac{0{,}02}{0{,}2}$ √

$= 0{,}10\ mol.dm^{-3}$√ (4)

5.3 $Al_2(SO_4)_3(s) \rightarrow 2\ Al^{3+}(aq) + 3\ SO_4^{2-}(aq)$

C (SO_4^{2-}) = 3 x c ($Al_2(SO_4)_3$)

= 3 (0, 10) √

$= 0{,}30\ mol.dm^{-3}$ √ (2)

5.4 In order to calculate the concentration of the final mixture we need to know the total number of moles of Al^{3+} ions present in the mixture.

So, in $Al_2(SO_4)_3$: n = cV

= (0,2)(0,1) √

= 0,02 mol

In $AlCl_3$: n = cV

= (0,1)(0,1) √

= 0,01 mol

So, the total number of moles of Al^{3+} ions in the mixture :

n_{total} = 0, 02 + 0, 01 √

= 0, 03 mol

$C = \frac{n}{V}$ √

$= \frac{0,03}{0,2}$ √

= 0, 15 $mol.dm^{-3}$ √ (6)

[14]

QUESTION 6

6.1 $n(CO_2) = \frac{m}{M}$

$= \frac{6,21 \times 10^{-3}}{44}$ √

$= 0,00014113636$ mol

$n(C) = n(CO_2)$ √

$= 0,00014113636$ mol √ (3)

6.2 $m(C) = nM$ √

$= (0,00014113636)(12)$ √

$= 0.00169363636$ g √ (3)

6.3 Mass % C $= \frac{0.00169363636}{4,24 \times 10^{-3}} \times 100$ √

$= 39,94$ % √ (2)

6.4 $n(H_2O) = \frac{m}{M}$

$= \frac{2,54 \times 10^{-3}}{18}$ √

$= 0,000141111$ mol

$n(H) = 2\,n(H_2O)$ √

$= 2\,(0,000141111)$

$= 0,0002822222$ mol √

$m(H) = nM$ √

$= (0,0002822222)(1)$ √

$= 0,0002822222$ g √ (6)

6.5 Mass % H $= \frac{0,0002822222}{4,24 \times 10^{-3}} \times 100$ √

$= 6,66\%$ √ (2)

6.6 Mass % O $= 100 - 39,94 - 6,66$ √

$= 53,40$ % √ (2)

6.7 Mole ratio = n(C) : n(H) : n (O)

$= \frac{39,94}{12} : \frac{6,66}{1} : \frac{53,4}{16}$ √

= 3,328333 : 6,66 : 3,3375 √

= 1 :2:1 √

Empirical formula is CH_2O √ (4)

6.8 Molecular formula = $\frac{molar\ mass\ (compound)}{molar\ mass\ (empirical\ formula)}$ (empirical formula)

$= \frac{60}{30}$ √√ (CH_2O)

= 2 (CH_2O)

= $C_2H_4O_2$ √ (3)

[25]

QUESTION 7

7.1 Oxygen √

$n(NH_3) = \frac{m}{M}$ $n(O_2) = \frac{m}{M}$

$= \frac{500}{17}$ √ $= \frac{500}{32}$ √

= 29,4118 mol = 15,625 mol

Suppose all $n(NH_3)$ is used up :

$n(O_2) : n(NH_3) = 5 : 4$

$n(O_2) = \frac{5}{4}\ n(NH_3)$

$= \frac{5}{4}\ (29{,}4118)$ √

= 36, 76475 mol √

36, 76475 mol > 15,625 mol available √

Oxygen is the limiting reagent

OR

Suppose all $n(O_2)$ is used up :

$n(NH_3) : n(O_2) = 4 : 5$

$n(NH_3) = \frac{4}{5}\ n(O_2)$

$= \frac{4}{5}\ (15{,}625)$

= 12,5 mol

12,5 mol < 29,4118 mol available

Ammonia is in excess

Hence Oxygen is the limiting reagent

7.2 12,50 mol NH_3 will produce 12,50 mol NO √

m (NO) = nM

= (12,50)(30) √

= 375 g

% yield = $\frac{210}{375}$ x 100 √

= 56% √

(4)

TOTAL: 100