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Province of the
EASTERN CAPE
EDUCATION

OR TAMBO INLAND DISTRICT

GRADE 11

PHYSICAL SCIENCES

Controlled Test

SEPTEMBER 2023

MARKS: 100

TIME: 2 HOURS

This question paper consists of 10 pages, including 2 data sheet.

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INSTRUCTIONS AND INFORMATION

1. Write your FULL NAME and SURNAME on the ANSWER SCRIPT.
2. The question paper consists of 7 questions. Answer ALL the questions in the ANSWER SCRIPT.
3. Start EACH question on a new page in the ANSWER SCRIPT.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE-line open 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. 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.
11. Give brief explanations, motivations, et cetera where required.
12. Write neatly and legibly.

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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 only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example.

1.1 A few drops of bromothymol blue indicator are added to a hydrochloric acid solution, HCℓ(aq). When ammonium hydroxide, $NH_4OH(aq)$, is added to this solution, the colour of the indicator will change from …

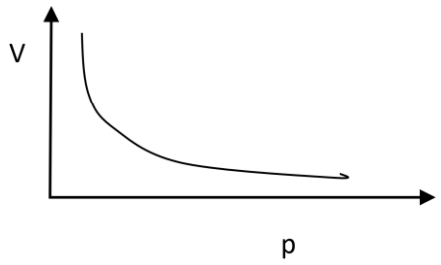
A yellow to blue.
B blue to red.
C blue to yellow.
D yellow to red. (2)

1.2 The CORRECT formula for ethanoic acid:

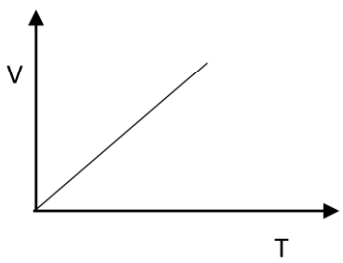
A HNO_3
B H_2SO_4
C CH_3COOH
D NH_3 (2)

1.3 Which of the following graph does not illustrate the behaviour of the ideal gas?

A



B



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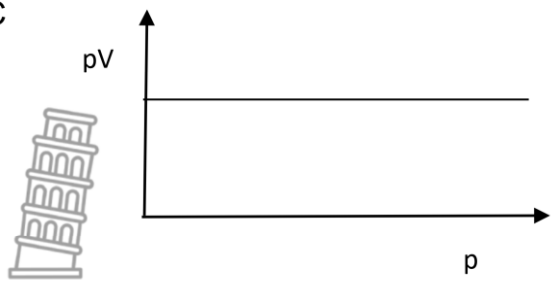
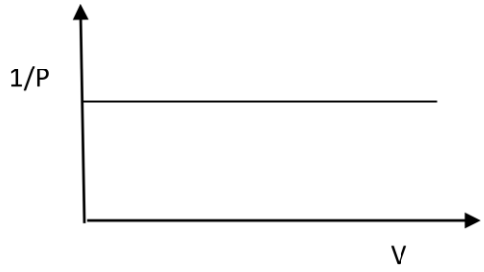
C



D



(2)

1.4 According to Boyle's law, …

A p α 1/ V if T is constant.

B V α T if p is constant.

C p α V if n is constant.

D V α 1/T if p is constant. (2)

1.5 In a 20 g sample of molecules, which sample below has the greatest number of moles?

A NH_3

B N_2

C CO_2

D H_2 (2)

1.6 The chemical equation that represents an endothermic reaction:

A $Zn(s) + 2HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g) + heat$

B $NH_4NO_3(s) + H_2O(\ell) \rightarrow NH_4^+(aq) + NO_3^-(aq)$ $\Delta H > 0$

C $H_2(g) + C\ell_2(g) \rightarrow 2HC\ell(g)$ $\Delta H = -131\ kJ{\cdot}mol^{-1}$

D $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$ $\Delta H < 0$ (2)

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1.7 0.5 mol sodium sulphate is dissolved in 500 cm^3 water. The concentration of the sodium sulphate is ..

A 0.25 $mol.dm^{-3}$

B 0.5 $mol.dm^{-3}$

C 1.0 $mol.dm^{-3}$

D 2.0 $mol.dm^{-3}$ (2)

1.8 The number of ions present in 2 moles of $CuC\ell_2$ is …

A $2 \times 6{,}02 \times 10^{23}$

B $4 \times 6{,}02 \times 10^{23}$

C $6 \times 6{,}02 \times 10^{23}$

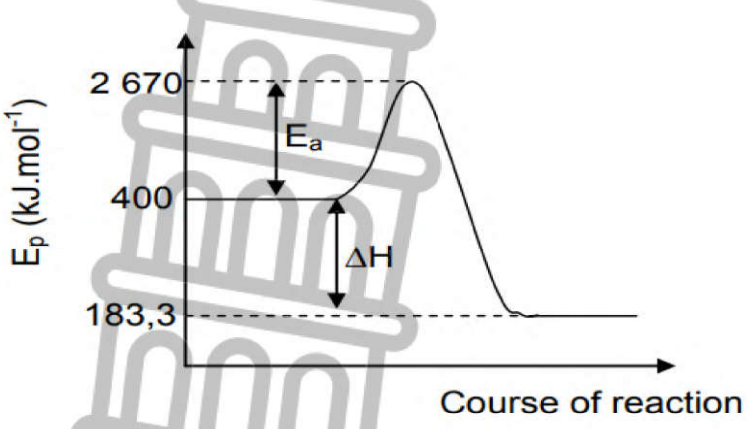
D $9 \times 6{,}02 \times 10^{23}$ (2)

[16]

QUESTION 2

The following reaction between ammonia and oxygen takes place in a closed system at constant pressure and temperature:

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



2.1 Define the term activated complex (2)

2.2 Is the reaction exothermic or endothermic? Give a reason for the answer. (2)

2.3 Use the information on the graph and write down the value of the:

2.3.1 Activated complex (2)

2.3.2 Energy absorbed (2)

2.3.3 Heat of reaction (2)

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2.3.4 Activation energy for the reverse reaction. (2)

2.4 Now catalyst is added to the above reaction

2.4.1 Redraw the graph and show the effect of the addition of the catalyst. (2)

[14]

QUESTION 3

Consider the balanced equations for the reaction of water with nitric acid and ammonia below:

Reaction 1: $HNO_3(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + NO_3^-(aq)$

Reaction 2: $NH_3(g) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$

3.1 Define a base in terms of the Lowry-Brønsted theory. (2)

3.2 Write down the FORMULA or NAME of ampholyte in the above reactions. (2)

3.3 Write down the formulae of the TWO conjugate acid-base pairs in Reaction 2 (4)

3.4 Is the solution formed in Reaction 2 ACIDIC or BASIC (ALKALINE)? Give a reason for the answer (2)

3.5 Calcium hydroxide reacts with nitric acid to produce the following product and an unknown **Y**. The equation for the reaction is:

$Ca(OH)_2(aq) + HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + \mathbf{Y}(\ell)$

3.5.1 Write down the FORMULA of the substance represented by **Y**. (2)

3.5.3 Write down a balanced equation for the dissolution of sulphuric acid (3)

3.6 Describe the term acid-base indicator (2)

3.7 0.365g of hydrogen chloride dissolve in 500 cm^3 water at 25 °C.

$HC\ell(aq) + H_2O(\ell) \rightleftharpoons C\ell^-(aq) + H_3O^+(aq)$

3.7.1 Define the term concentration. (2)

Calculate:

3.7.2 The concentration of the $HC\ell$ (4)

3.7.3 The concentration of H_3O^+ (2)

[25]

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QUESTION 4

A major textile dye manufacturer developed a new yellow dye. The dye has a percent composition of 75.95% C, 17.72% N, and 6.33% H by mass with a molar mass of about 240 $g.mol^{-1}$.

4.1 Define the term empirical formula. (2)

4.2 Determine the empirical formula of this compound. (5)

4.3 Determine the molecular formula of this compound (2)

[9]

QUESTION 5

Sodium burns in oxygen according to the following reaction:

$4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$

483g sodium placed in a container with 5.8 mol oxygen gas.

5.1.1 Define the term limiting reagent. (2)

5.1.2 Determine the limiting reagent in this reaction. (6)

5.1.3 Calculate the mass of sodium oxide that can be produced. (3)

5.1.4 Calculate the volume of O_2 reacted at STP. (3)

5.2 Consider the balanced chemical equation of magnesium hydroxide with phosphoric acid.

$3\ Mg(OH)_2 + 2H_3PO_4 \rightarrow Mg_3(PO_4)_2 + 6H_2O$

5.2.1 Calculate the mass of $Mg_3(PO4)_2$ that will be formed (assuming 100% yield) from the reaction of 15.0 g of 92.5% of $Mg(OH)_2$ with an excess of H_3PO_4. (8)

[22]

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QUESTION 6

Consider the reaction between sulphur dioxide and oxygen to produce sulphur trioxide. 4 g of sulphur trioxide is produced at STP

$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

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

6.2 Calculate the:

6.2.1 Number of moles of sulphur dioxide (3)

6.2.2 Volume of sulphur dioxide required in the reaction (3)

6.2.3 mass of oxygen that has been used up in the reaction (4)

6.3 Write down a combustion reaction of C_4H_{10} with excess oxygen. (2)

[14]

TOTAL: 100

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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	$22{,}4\ dm^3{\cdot}mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

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

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TABLE 3: THE PERIODIC TABLE OF ELEMENTS/*TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE*

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 87 Fr	0,9 88 Ra 226	89 Ac															

KEY/*SLEUTEL*

Atomic number *Atoomgetal*

Electronegativity *Elektronegatiwiteit* → 29 Cu 1,9 63,5 ← Symbol *Simbool*

Approximate relative atomic mass *Benaderde relatiewe atoommassa*

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

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GRADE 11

PHYSICAL SCIENCES

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September 2023

MEMORANDUM

MARKS: 100

THIS MEMORANDUM CONSISTS OF SIX PAGES

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QUESTION 1

1.1 A ✓✓
1.2 C✓✓
1.3 D✓✓
1.4 A✓✓
1.5 D✓✓
1.6 B✓✓
1.7 C✓✓
1.8 C✓✓

[16]

QUESTION 2

2.1 Activated complex is the unstable transition state from reactants to products. ✓✓ (2)

2.2 Exothermic ✓. $H_{products} < H_{reactants}$ ✓/The energy of the products is less than the energy of the reactants (2)

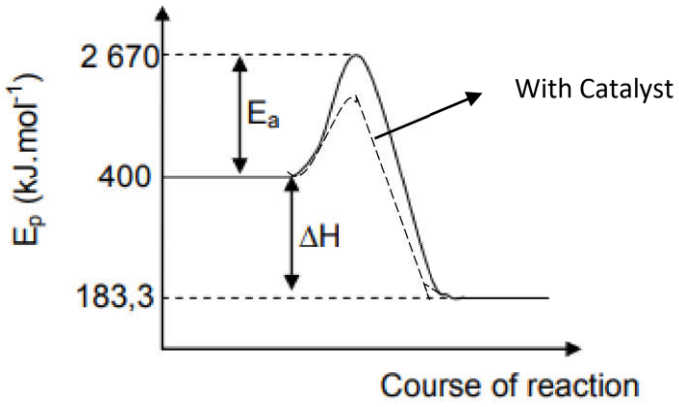
2.3.1 2670 $kJ.mol^{-1}$ ✓✓ (2)

2.3.2 2270 $kJ.mol^{-1}$ ✓✓ (2)

2.3.3 $\Delta H = -216.7\ kJ.mol^{-1}$ ✓✓ (2)

2.3.4 2486.7 $kJ.mol^{-1}$ ✓✓ (2)

2.4.1



(2)

[14]

QUESTION 3

3.1 A base is a proton/H+ ion acceptor. ✓✓ (2)

3.2 H_2O/Water ✓✓ (2)

3.3 H_2O/ OH^-✓✓ (4)
NH_4^+/ NH_3✓✓

3.4 BASIC (ALKALINE) ✓ (2)
There is presence of OH^- ions in solution. ✓

3.5.1 H_2O ✓✓ (2)

3.5.2 $\underline{H_2SO_4 + H_2O}$ ✓ ⇌ $H_3O^+ + SO_4^{2-}$ ✓ Balanced ✓ (3)

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3.6 An acid-base indicator is a weak acid, or a weak base, which colour changes as the H^+ ion concentration or the OH^- ion concentration in a solution changes. ✓✓ (2)

3.7.1 Concentration is the amount of solute per litre of solution. ✓✓ (2)

3.7.2 Option 1

$c = \frac{m}{MV}$ ✓

$c = \frac{0.365}{(36.5✓)(0.5✓)}$

$c = 0.02\ mol.dm^{-3}$ ✓

Option 2

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

$n = \frac{0.365}{36.5✓}$

$n = 0.01\ mol$ ✓

$c = \frac{n}{V}$

$c = \frac{0.01}{0.5✓}$

$c = 0.02\ mol.dm^{-3}$ ✓ (4)

3.7.3 1 : 1✓ (2)

$c(HCℓ) = c(H_3O^+)$

$c(H_3O^+) = 0.02\ mol.dm^{-3}$✓

[26]

QUESTION 4

4.1 Empirical formula as the simplest whole-number ratio of atoms in a compound. ✓✓ (2)

4.2 $n\ \frac{m}{M}$

$n(C) = \frac{75.95}{12}$✓ = 6.329

$n(N) = \frac{17.72}{14}$✓ = 1.266

$n(H) = \frac{6.33}{1}$ ✓= 6.33

C : N : H

$\frac{6.329}{1.266} : \frac{1.266}{1.266} : \frac{6.33}{1.266}$ ✓

5 : 1 : 5

C_5H_5N✓ (5)

4.3 $n = \frac{240}{79} = 3$ ✓ (2)

$C_{15}H_{15}N_3$ ✓

[9]

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QUESTION 5

5.1.1 Limiting reagent in a reaction is the reactant that is consumed completely. ✓✓ (2)

5.1.2 $n(Na) = \frac{m}{M}$ ✓

$n(Na) = \frac{483}{23}$ ✓

$n(Na) = 21\ mol$ ✓

$Na : O_2$

4 : 1✓

$\frac{21}{4} : \frac{5.8}{1}$

5.25 < 5.8✓

$Na\ is\ a\ limiting\ reagent$ ✓ (6)

5.1.3 $Na : Na_2O$

4 : 2 ✓

21 : n

$n(Na_2O) = 10.5\ mol$✓

$10.5 = \frac{m}{62}$

$m = 651g$ ✓ (3)

5.1.4 $Na : O_2$

4 : 1

21 : n

$n(O_2) = 5.25$ mol

$n\ (O_2) = \frac{V}{V_m}$ ✓

$5.25 = \frac{V}{22.4}$ ✓

V = 117. 6 dm^3 ✓ (3)

5.2.1 $M_{reacted}$ = 15 x 0.925%

= 13.88 g✓

$n\ (Mg(OH)_2) = \frac{m}{M}$

$= \frac{13.875}{58}$✓

= 0.2392 mol

$Mg(OH)_2 : Mg_3(PO_4)_2$

3 : 1✓

0.2392 : n

n = 0.07973 mol

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$0.07973 = \frac{m}{262}$ ✓

n = 20.88926 g✓

$\%\ Yield = \frac{Actual\ mass}{theoretical} \times 100$

$100 = \frac{Actual\ mass}{20.88926} \times 100$ ✓

m = 20.89 g✓

(7)
[21]

QUESTION 6

6.1 One mole of any gas occupies the same volume at the same temperature and pressure✓✓ (2)

6.2.1 $n\ (SO_3) = \frac{m}{M}$

$n\ (SO_3) = \frac{4}{80}$ ✓

$n\ (SO_3) = 0.05\ mol$ ✓

$SO_3 : SO_2$

2 : 2

$n\ (SO_3) = n\ (SO_2)$

$n\ (SO_2)$ = 0.05 mol✓ (3)

6.2.2 $n = \frac{V}{V_m}$ ✓

$0.05 = \frac{V}{22.4}$ ✓

V = 1.12 dm^3✓

(3)

6.2.3 $SO_2 : O_2$

2 : 1 ✓

0.05 : n

$n(O_2)$ = 0.025mol✓

$m\ (O_2) = 0.025 \times 32$ ✓

$m\ (O_2) = 0.8$ g✓ (4)

6.3 $C_4H_{10} + O_2 \rightarrow CO_2$ ✓+ H_2O✓ (2)

[14]
[100]

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