Education

KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

COMMON TEST

MARCH 2018

MARKS : 50

TIME : 1 Hour

This question paper consists of 8 pages including 2 data sheets.

Please Turn Over

INSTRUCTIONS AND INFORMATION TO CANDIDATES

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

2. The question paper consists of FOUR questions. Answer ALL the 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

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A - D) next to the question number (1.1. – 1.4) in the ANSWER BOOK, for example 1.5 D.
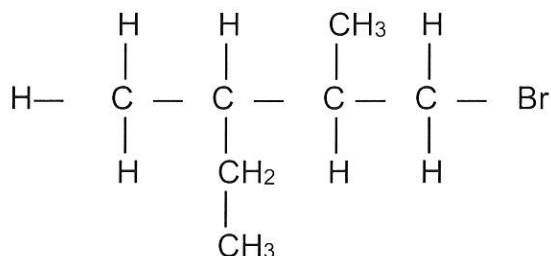
1.1   Which ONE of the compounds represented below is an UNSATURATED hydrocarbon?

    A CH_2CHCH_3
    B $CH_3CH_2CH_3$
    C $CH_3(CH_2)_3CH_3$
    D $CH_3C(CH_3)_2CH_3$ (2)

1.2   A compound that is an isomer of methyl pentanoate is . . .

    A   ethyl butanoate
    B   pentanoic acid
    C   hexane – 1,2 – diol
    D   methyl methanoate   (2)

1.3   The formula of an organic compound is given below:

    The correct IUPAC name for the above compound is . . .

    A   1-bromo-2,3-dimethylbutane.
    B   1-bromo-2,3-dimethylpentane.
    C   1-bromo-3-ethyl-2-methylbutane.
    D   1-bromo-2-ethyl-3-methylpentane.   (2)

1.4   Which ONE of the following statements is NOT TRUE?

    A   Water is formed in condensation polymerisation.
    B   Addition polymers form more slowly than condensation polymers.
    C   The monomers of addition polymers contain carbon-carbon double bonds.
    D   The monomers of condensation polymers contain functional groups such as alcohols and carboxylic acids.   (2)
    [8]

QUESTION 2 (Start on a new page.)

Consider the following representation of organic compounds **A** to **H** listed in the table below to answer the questions that follow:

A	4-ethyl-2,2-dimethylhexane	B	$CH_3 - CH_2 - CH_2 - \overset{\displaystyle O}{\overset{\displaystyle \|}{C}} - H$
C	$H - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{\displaystyle \|}{\underset{\displaystyle \|}{C}}}} - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{\displaystyle \|}{\underset{\displaystyle \|}{C}}}} - \overset{\displaystyle }{\underset{\displaystyle O}{\overset{\displaystyle }{\underset{\displaystyle \|}{C}}}} - \overset{\displaystyle H}{\underset{\displaystyle H}{\overset{\displaystyle \|}{\underset{\displaystyle \|}{C}}}} - H$	D	$CH_3 - CH_2 - \overset{\displaystyle O}{\overset{\displaystyle \|}{C}} - O - CH_2 - CH_3$
E	$\overset{\displaystyle CH_3 \quad\quad CH_3}{\underset{\displaystyle CH_3}{\overset{\displaystyle \|\quad\quad\quad \|}{CH_2 - \underset{\displaystyle \|}{C} - Br}}}$	F	Pentane

2.1   Write down the:

       2.1.1   Name of the functional group of compound C.   (1)

       2.1.2   General formula of the homologous series to which compound A belongs.   (1)

       2.1.3   Structural formula for compound A.   (3)

       2.1.4   Letter representing the compound which is an aldehyde.   (1)

2.2   Write down the letters that represent TWO compounds that are FUNCTIONAL ISOMERS of each other, in the above table.   (1)

2.3   Is compound E, a PRIMARY, SECONDARY or TERTIARY haloalkane? Give a reason for the answer.   (2)

2.4   Compound D is prepared in the laboratory.

       2.4.1   How can one quickly establish whether compound D is indeed formed?   (1)

       2.4.2   Write down the IUPAC name of the ORGANIC ACID required to prepare compound D.   (2)

2.5   A 10,00g sample of compound F undergoes complete combustion. The equation below illustrates the reaction that occurs:

$$C_5H_{12} + 8 O_2 \longrightarrow 5 CO_2 + 6 H_2O$$

Calculate the volume of CO_2 that will be produced at 25 °C, if the molar volume of CO_2 at this temperature is 24 000,00 cm^3.   (4)

[16]

QUESTION 3 (Start on a new page.)

An experiment was conducted to determine the boiling points of the isomers of C_5H_{12}. The following data was obtained:

ISOMER	BOILING POINT
Pentane	36 °C
2-methylbutane	25 °C
2,2 - dimethylpropane	10 °C

3.1   For this investigation, write down the:

     3.1.1   dependant variable.   (1)

     3.1.2   independent variable.   (1)

3.2   Define *boiling point*.   (2)

3.3   Explain fully the trend in boiling points as depicted in the table.   (4)

3.4   Which compound, pentane or 2-methylbutane, has a lower vapour pressure? Give a reason for the answer.   (2)

3.5   A learner observes, in another experiment, that although both propan-1-ol and ethanoic acid have the same molecular mass, their boiling points differ.

     3.5.1 Which compound propan-1-ol or ethanoic acid will have the higher boiling point.   (2)

     3.5.2 Refer to the type and strength of the intermolecular forces to account for the difference in boiling points.   (3)

[15]

QUESTION 4 (Start on a new page.)

In the flow diagram below, the letters X, Y and Z represent organic reactions, while the letters P and Q represent organic compounds.
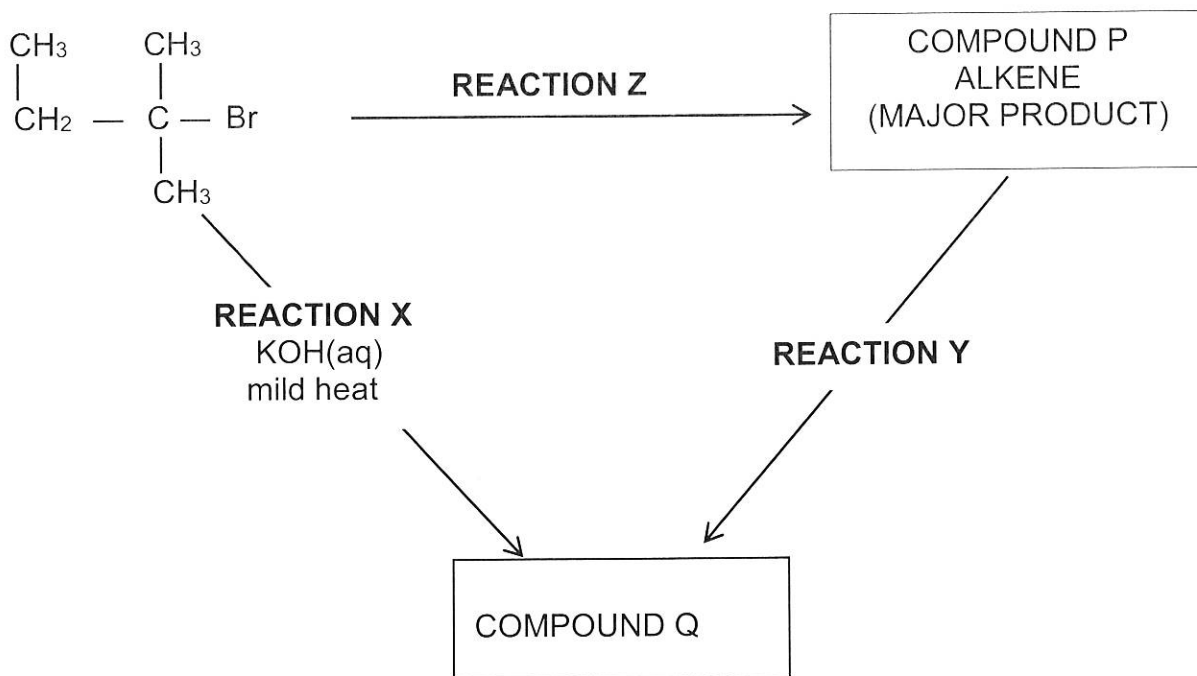
4.1   Reaction X represents a substitution reaction.

4.1.1. Give a reason why reaction X CANNOT be an addition reaction.   (1)

4.1.2   Write down the name of this substitution reaction.   (1)

4.1.3   Write down the structural formula of compound Q.   (2)

4.2   Write down the type of:

4.2.1   Elimination reaction represented by Z.   (1)

4.2.2   Addition reaction represented by Y.   (1)

4.3   For the reaction Z write down:

4.3.1   The name of the inorganic reagent needed.   (1)

4.3.2   TWO reaction conditions needed.   (2)

4.4   Write down the condensed structural formula of the POSITIONAL ISOMER of
        compound P.   (2)
                                                                           [11]

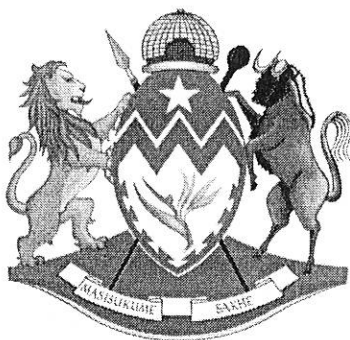   TOTAL MARKS: 50

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
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
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \dfrac{m}{M}$	$n = \dfrac{N}{N_A}$
$c = \dfrac{n}{V}$ or/*of* $c = \dfrac{m}{MV}$	$n = \dfrac{V}{V_m}$
$\dfrac{c_a V_a}{c_b V_b} = \dfrac{n_a}{n_b}$	pH = $-\log[H_3O^+]$

$$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14} \text{ at/}by\ 298 \text{ K}$$

$$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode} \ / \ E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$$

or/*of*

$$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation} \ / \ E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$$

or/*of*

$$E^\theta_{cell} = E^\theta_{oxidising\,agent} - E^\theta_{reducing\,agent} \ / \ E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMEN

KEY/SLEUTEL

Atomic number
Atoomgetal

Symbol
Simbool

Electronegativity
Elektronegatiwiteit

$\begin{array}{c} 29 \\ 1,9 \quad \text{Cu} \quad 63,5 \end{array}$

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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	1,9 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

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MEMORANDUM

NATIONAL SENIOR CERTIFICATE

GRADE 12

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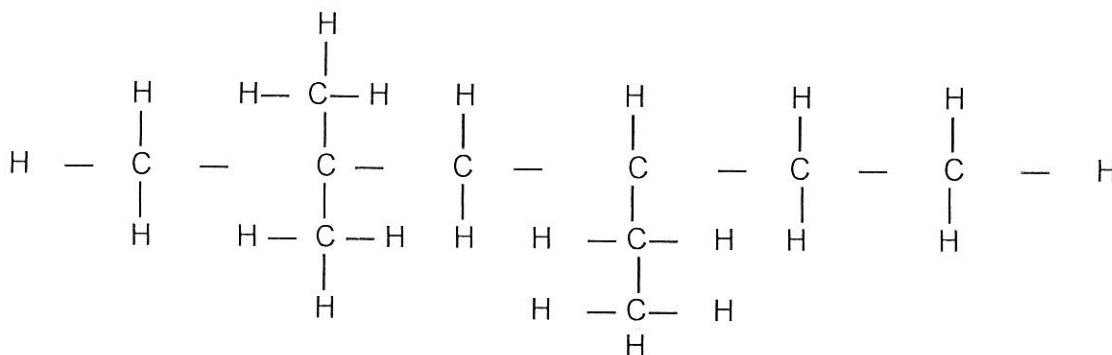This memorandum consists of 4 pages.

The marking guidelines as per 2014 Examination Guidelines, pages 34-37 must be applied when marking this Paper.

QUESTION 1

1.1 A ✓✓ (2)

1.2 A✓✓ (2)

1.3 B✓✓ (2)

1.4 B✓✓ (2)

[6]

QUESTION 2

2.1.1 carbonyl ✓ (Accept ketone group) (1)

2.1.2 C_nH_{2n+2} ✓ (1)

2.1.3 - 6 C parent chain✓

- all 3 branches correctly placed✓

- whole structure correct✓

(3)

2.1.4 B✓ (1)

2.2 B and C✓ (1)

2.3 tertiary✓

The C that is bonded to the halogen group is bonded to three other carbon atoms✓ (2)

2.4.1 identify by odour/smell✓ (1)

2.4.2 propanoic acid✓✓ (2)

2.5 $n(CO_2)$ = $5n(C_5H_{12})$ = 5(m/M)

           = 5(10/72)

           = 0,694 mols✓

$n(CO_2)$ = V/Vm✓

0,694 = V/24✓

V = 16,656 dm³✓

Mark allocation:
Number of moles
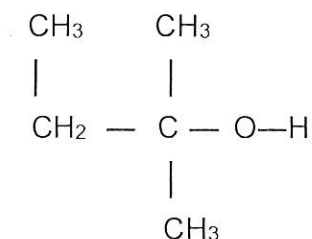Formula
substitution
answer

(4)

[16]

QUESTION 3

3.1.1 Boiling point✓ (1)

3.1.2 length of carbon chain/surface area/branching✓ *Dont accept isomer.* (1)

3.2 the temperature ✓at which the vapour pressure of liquid equals the atmospheric pressure. ✓ (2)

3.3 The boiling point decreases from pentane to 2,2 – dimethylpropane.
From pentane to 2,2 – dimethylpropane, the length of the carbon chain decreases/surface area decreases/number of branches increases. ✓
The amount of London forces decreases✓ resulting in weaker intermolecular✓ forces that require less energy to overcome. ✓

OR

The boiling point increases from 2,2 – dimethylpropane to pentane.
From 2,2 – dimethylpropane to pentane, the length of the carbon chain increases/surface area increases/number of branches decreases. ✓
The amount of London forces increases✓ resulting in stronger intermolecular ✓ forces that require more energy to overcome. ✓   *reverse.* (4)

3.4 pentane. ✓
Has a higher boiling point, (As Vapour pressure increases the boiling Point decreases). ✓ *Accept imf between pentane molecules.* (2)

3.5.1 ethanoic acid✓✓ (2)

3.5.2 Propan-1 - ol has London forces and one Hydrogen Bond between adjacent molecules. *accept ✓* Ethanoic acid has London forces and two Hydrogen Bonds between adjacent molecules. There are stronger intermolecular forces between ethanoic acid molecules. ✓ (3)

[15]

QUESTION 4

4.1.1 The reactant for X is saturated/contains only single bonds/contains no multiple
        Bonds between carbon atoms✓   (1)

4.1.2 Hydrolysis ✓   (1)

4.1.3

Accept condensed structural formula.

```
   CH₃      CH₃
    |        |
   CH₂ ―  C ― O―H            Functional group✓
            |                 Whole structure✓
           CH₃
```
                                                                                             (2)

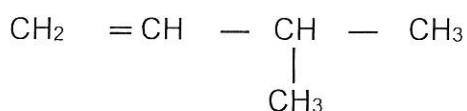4.2.1 dehydrohalogenation✓   (1)

4.2.2 hydration✓   (1)

4.3.1 sodium hydroxide/potassium hydroxide✓ *(Name not formula).*   (1)

4.3.2 heat (strongly)✓
        dissolve NaOH in ethanol/concentrated NaOH✓   (2)

4.4

```
   CH₂   = CH  ―  CH  ―  CH₃
                   |
                  CH₃
```

Must be condensed.

                                              OR

```
   CH₃  ― CH₂  ―  C  =  CH₂
                   |
                  CH₃
```

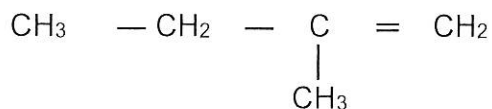   Functional group✓
        Whole structure✓   (2)
                                                                                            [11]

                                                          TOTAL MARKS: [50]