basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 11

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2015

MEMORANDUM

MARKS/*PUNTE*: 150

This memorandum consists of 12 pages.
Hierdie memorandum bestaan uit 12 bladsye.

QUESTION 1/*VRAAG 1*

1.1 D ✓✓ (2)

1.2 C ✓✓ (2)

1.3 D ✓✓ (2)

1.4 B ✓✓ (2)

1.5 D ✓✓ (2)

1.6 B ✓✓ (2)

1.7 B ✓✓ (2)

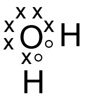
1.8 A ✓✓ (2)

1.9 A ✓✓ (2)

1.10 D ✓✓ (2)
[20]

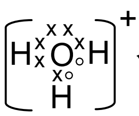
QUESTION 2/*VRAAG 2*

2.1 The sharing of electrons ✓ between (two) atoms (to form a molecule). ✓
Die deling van elektrone tussen (twee) atome (om 'n molekuul te vorm). (2)

2.2  ✓✓

Marking criteria/*Nasienriglyne:*
• O atom shown with 8 electrons around it. *O-atoom getoon met 8 elektrone rondom dit.* • Two electron pairs on O atom shared with two H atoms as shown. *Twee elektronpare op O-atoom word gedeel met H-atome soos getoon.*

(2)

2.3
2.3.1  ✓ (1)

2.3.2
- One atom/ion must have an empty valence shell / orbital. ✓
  Een atoom/ioon moet 'n leë valensskil/orbitaal hê.
- The other atom must have a lone pair of electrons. ✓
  Die ander atoom moet 'n alleenpaar-elektrone hê. (2)

2.4
2.4.1 The tendency of an atom in a molecule ✓ to attract bonding electrons closer to itself. ✓
Die neiging van 'n atoom in 'n molekuul om bindingselektrone nader aan ditself aan te trek. (2)

2.4.2 (a) ΔEN(between C and O/*tussen C en O*) =1 ✓ (1)

(b) ΔEN(between H and O/*tussen H en O*) =1,4 ✓ (1)

2.4.3
- The bonds in both molecules are polar ✓due to the difference in electronegativities ✓ between C and O and H and O.
  Die bindings in beide molekule is polêr weens die verskil in elektronegatiwiteit tussen C en O en H en O.
- The shape of the H_2O molecule is angular ✓ and therefore the molecule is polar ✓ because one side of the molecule can be positive and the other side negative.
  Die vorm van die H_2O-molekuul is hoekig en dus is die molekuul polêr omdat een kant van die molekuul positief en die anderkant negatief kan wees.
- The shape of the CO_2 molecule is linear ✓and thus it is non-polar ✓ because the the charge distribution is symmetrical.
  Die vorm van die CO_2-molekuul is liniêr en dus is die molekuul nie-polêr omdat die ladingsverspreiding simmetries is. (6)

[17]

QUESTION 3/*VRAAG 3*

3.1

3.1.1 The temperature ✓at which the vapour pressure of a liquid equals external (or atmospheric) pressure. ✓
Die temperatuur waarby die dampdruk van 'n vloeistof gelyk is aan die eksterne (of atmosferiese) druk. (2)

3.1.2 M = 6(12) + 14(1)
= 86 $g \cdot mol^{-1}$ ✓ (1)

3.1.3 Gas ✓ (1)

3.1.4 London/dispersion/induced dipole forces ✓
London-/dispersie-/geïnduseerde-dipoolkragte (1)

3.1.5
- Molecular mass increases from A to E. ✓
Molekulêre massa neem toe van A tot E.
- Strength of intermolecular forces/London forces/dispersion forces/ induced dipole forces increases. ✓
Sterkte van intermolekulêre kragte/Londonkragte/dispersiekragte/geïnduseerde dipoolkragte neem toe.
- More energy is needed to overcome/break the intermolecular forces. ✓
Meer energie benodig om intermolekulêre kragte/Londonkragte/ dispersiekragte/geïnduseerde dipoolkragte te oorkom/breek.

OR/*OF*
- Molecular mass decreases from E to A. ✓
Molekulêre massa neem af van E tot A.
- Strength of intermolecular forces/London forces/dispersion forces/induced dipole forces decreases. ✓
Sterkte van intermolekulêre kragte/Londonkragte /dispersiekragte/geïnduseerde dipoolkragte neem af.
- Less energy is needed to overcome the intermolecular forces. ✓
Minder energie benodig om intermolekulêre kragte/Londonkragte/ dispersiekragte/geïnduseerde dipoolkragte te oorkom/breek. (3)

3.1.6 Higher than/*Hoër as* ✓ (1)

3.2
3.2.1 H_2S ✓ (1)

3.2.2 Hydrogen bonding/*Waterstofbinding* ✓ (1)

3.2.3 Hydrogen bonding between H_2O molecules ✓is stronger ✓ than the London forces/dispersion forces/induced dipole forces or dipole-dipole forces between H_2S molecules. ✓
More energy is needed to overcome/break the intermolecular forces in water. ✓

Waterstofbinding tussen H_2O-molekule is sterker as die Londonkragte/ dispersiekragte/geïnduseerde dipoolkragte of dipool-dipoolkragte tussen H_2S-molekule.
Meer energie benodig om intermolekulêre kragte in water te oorkom/breek. (4)
[15]

QUESTION 4/*VRAAG 4*

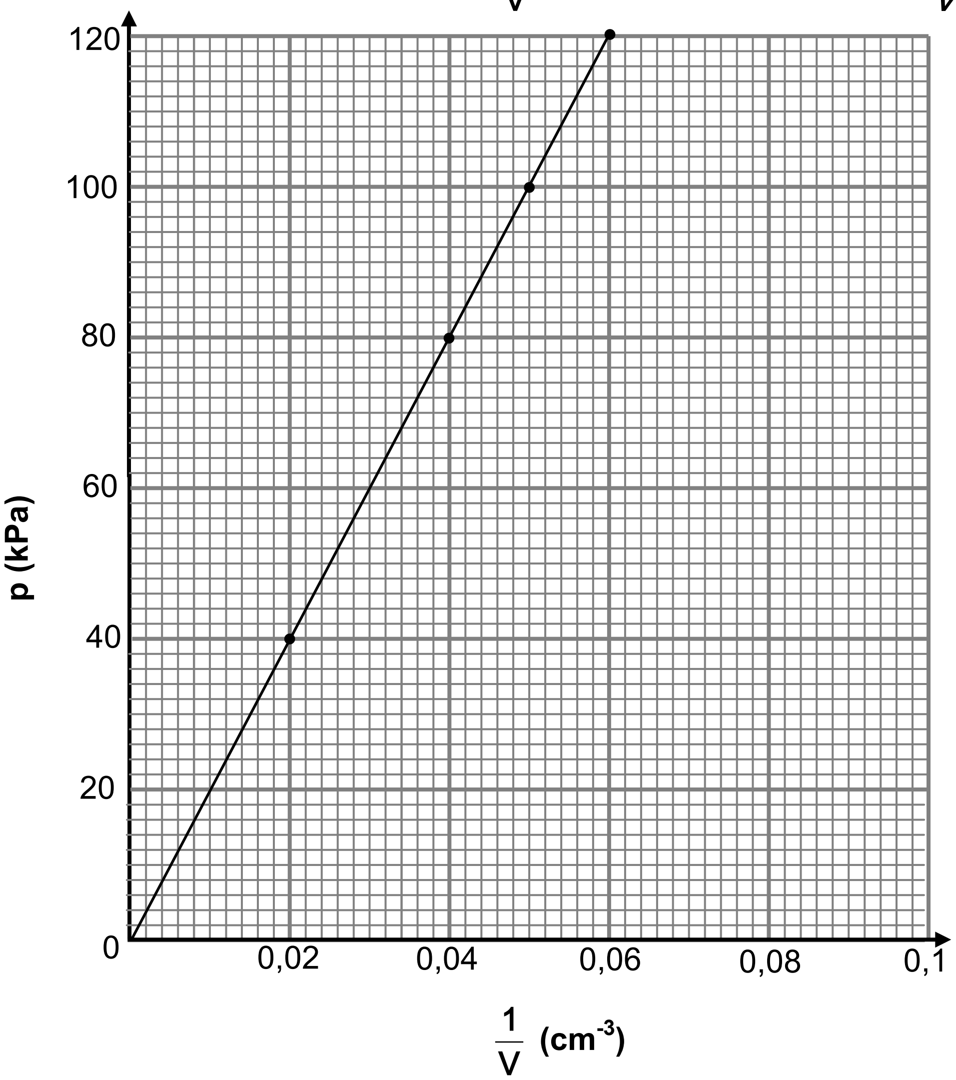
4.1 Boyle's law / *Boyle se wet* ✓ (1)

4.2

Pressure ***Druk* (kPa)**	**Volume (cm^3)**	$\frac{1}{V}$ **(cm^{-3})**
40	43	0,02
80	27	0,04
100	22	0,05 } ✓
120	18	0,06 }

(1)

4.3 **Graph of pressure versus $\frac{1}{V}$/*Grafiek van druk teenoor $\frac{1}{V}$***



Criteria for graph/*Riglyne vir grafiek:*	
Two points correctly plotted./*Twee punte korrek gestip.*	✓
Four points correctly plotted./*Vier punte korrek gestip.*	✓
Straight line of best fit drawn./ *Reguitlyn van beste passing getrek*.	✓
The straight line will intercept origin if extended. *Reguitlyn gaan deur oorsprong wanneer dit verleng word.*	✓

(4)

4.4 $\frac{1}{V}$ = 0,034 ✓ ∴ V = 29,41 cm^3 ✓

<u>Notes/*Aantekeninge:*</u>
IF/*INDIEN:*
Only answer given, allocate 2 marks./*Slegs antwoord gegee, ken 2 punte toe.*

(2)

4.5

4.5.1 $pV = nRT$ ✓
(100×10^3) ✓ (22×10^{-6}) ✓ $= n(8,31)(298)$ ✓
$\therefore n = 8,88 \times 10^{-4}$ mol

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

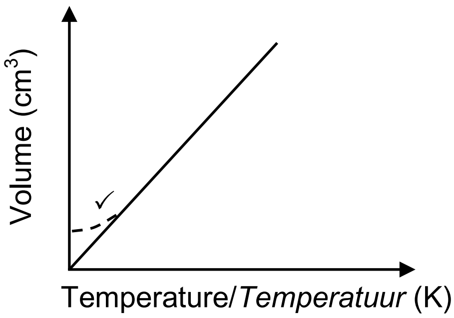
$$\therefore 8,89 \times 10^{-4} = \frac{2,49 \times 10^{-2}}{M}$$ ✓

$\therefore M = 28,03\ g{\cdot}mol^{-1}$ ✓ (6)

4.5.2 N_2 ✓ (1)

4.6

4.6.1



(1)

4.6.2 At low temperatures, <u>molecules move slower</u>/with less kinetic energy. ✓
<u>Intermolecular forces become more effective.</u> ✓
The <u>gas liquifies</u> and the volume (open space in container) is larger than predicted for ideal gases. ✓

By lae temperature beweeg <u>molekule stadiger</u>/met minder kinetiese energie.
<u>Intermolekulêre kragte word meer effektief</u>.
Die <u>gas vervloei</u> en die volume (oop ruimte in houer) is groter as voorspel vir ideale gasse. (3)

[19]

QUESTION 5/*VRAAG 5*

5.1 CO_2 ✓ (1)

5.2 The amount of substance ✓ having the same number of particles as there are atoms in 12 g carbon-12. ✓
Die hoeveelheid stof wat dieselfde getal deeltjies het as wat daar atome is in 12 g koolstof-12. (2)

5.3 $n(NaHCO_3) = \frac{m}{M}$ ✓
$= \frac{3,36}{84}$ ✓
$= 0,04$ mol ✓ (3)

5.4 **POSITIVE MARKING FROM QUESTION 5.3.**
POSITIEWE NASIEN VAN VRAAG 5.3.

$n(H_3C_6H_5O_7) = \frac{m}{M}$
$= \frac{1,8}{192}$ ✓
$= 0,01$ mol ($9,38 \times 10^{-3}$ mol)

$n(NaHCO_3$ needed/*benodig*$) = 3n(H_3C_6H_5O_7)$
$= 3(0,01)$ mol ✓
$= 0,03$ mol ✓

$n(NaHCO_3) < n(NaHCO_3$ in antacid/*in teensuurmiddel*$)$

$H_3C_6H_5O_7$/citric acid is the limiting reactant. ✓
$H_3C_6H_5O_7$/sitroensuur is die beperkende reagens. (4)

5.5 **POSITIVE MARKING FROM QUESTION 5.3 & 5.4.**
POSITIEWE NASIEN VAN VRAAG 5.3 & 5.4.

$n(NaHCO_3$ in excess/*oormaat*$) = 0,04 - 0,03$ ✓
$= 0,01$ mol

$m(NaHCO_3$ in excess/*oormaat*$) = nM$
$= (0,01)(84)$ ✓
$= 0,84$ g ✓ (3)

5.6 **POSITIVE MARKING FROM QUESTION 5.3.1.**
POSITIEWE NASIEN VAN VRAAG 5.3.1.

$n(CO_2) = \frac{m}{M}$
✓
$\therefore 0,03 = \frac{m}{44}$ ✓
$\therefore m(CO_2) = 1,32$ g ✓

Marking criteria/*Nasienriglyne:*
- Using/Gebruik $M(CO_2) = 44$ g·mol^{-1}
- $3(CO_2) = n(NaHCO_3)$
- Final answer: 1,32 g
  Finale antwoord: 1,32 g

(3)
[16]

QUESTION 6/*VRAAG 6*

6.1

6.1.1 The amount of solute ✓ per litre/cubic decimetre of solution. ✓
Hoeveelheid opgeloste stof per liter/kubieke desimeter oplossing. (2)

6.1.2 $c = \frac{n}{V}$ ✓

$0,2 = \frac{n}{200 \times 10^{-3}}$ ✓

= 0,04 mol ✓ (3)

6.1.3 **POSITIVE MARKING FROM QUESTION 6.1.2.**
POSITIEWE NASIEN VAN VRAAG 6.1.2.

$n(SO_2) = ½n(HCℓ)$
= ½(0,04) ✓
= 0,02 mol

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

$\therefore V = (0,02)(22,4)$ ✓
= 0,45 dm^3 ✓ (3)

6.2

6.2.1

<table>
<tr><td colspan="2"><u>Marking criteria/Nasienriglyne:</u>
• Substitute/Vervang 44 g·mol^{-1}. ✓
• $n(C) = n(CO_2)$ ✓
• Substitution/Vervang 12 g·mol^{-1}. ✓
• Final answer/Finale antwoord: 7,68 g ✓</td></tr>
<tr><td><u>OPTION 1/OPSIE 1</u>
$n = \frac{m}{M}$
$\therefore n(CO_2) = \frac{28,16}{44✓} = 0,64$ mol
$n(C) = n(CO_2)$ ✓ = 0,64 mol
m(C) = nM
= (0,64)(12) ✓
= 7,68 g ✓</td><td><u>OPTION 2/OPSIE 2</u>
$\%C \text{ in } CO_2 = \frac{12✓}{44✓} \times 100$
= 27,27%
$m(C) \text{ in } CO_2$ = 27,27% of 28,16 g✓
= 7,68 g ✓</td></tr>
</table>

(4)

6.2.2 **POSITIVE MARKING FROM QUESTION 6.3.1.**
POSITIEWE NASIEN VAN VRAAG 6.3.1.

Marking criteria/*Nasienriglyne:*
- Substitute $M(H_2O)$ to calculate $n(H_2O)$. ✓
  Vervang $M(H_2O)$ om $n(H_2O)$ te bereken.
- $n(H) = 2n(H_2O)$. ✓
- Substitution M(H) to calculate m(H). ✓
  Vervang M(H) om m(H) te bereken.
- M(O) = m(menthol) – (m(C) + m(H)) ✓
- Substitution M(O) to calculate n(O). ✓
  Vervang M(O) om n(O)te bereken.
- Ratio/*Verhouding:* mol C : mol H : mol O = 10 : 20 : 1 ✓
- Empirical formula/*Empiriese formule*: $C_{10}H_{20}O$ ✓

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
n(H) and m(H) $n = \frac{m}{M}$ $\therefore n(H_2O) = \frac{11,52}{18✓}$ = 0,64 mol $n(H) = 2n(H_2O)$ = 2(0,64) ✓ = 1,28 mol m(H) = nM = (1,28)(1) ✓ = 1,28 g n(O) and m(O) m(O) = 9,984 – (7,68 + 1,28) ✓ = 1,024 g $n(O) = \frac{1,024}{16}$ ✓ = 0,064 mol Ratio: mol C : mol H : mol O 0,64 : 1,28 : 0,064 10 : 20 : 1 ✓ Empirical formula: $C_{10}H_{20}O$ ✓ *Empiriese formule: $C_{10}H_{20}O$*	%H in $H_2O = \frac{2✓}{18✓} \times 100$ = 11,11% m(H) in H_2O = 11,11% of 11,52 g ✓ = 1,28 g m(O) = 9,984 – (7,68 + 1,28) = 1,024 g ✓ C : H : O $\frac{7,68}{12} : \frac{1,28}{1} : \frac{1,024}{16✓}$ 0,64 : 1,28 : 0,064 10 : 20 : 1 ✓ Empirical Formula: $C_{10}H_{20}O$ ✓ *Empiriese formule: $C_{10}H_{20}O$*

(7)

6.2.3 **POSITIVE MARKING FROM QUESTION 6.2.2.**
POSITIEWE NASIEN VAN VRAAG 6.2.2.
$M(C_{10}H_{20}O) = 10(12) + 20 + 16 = 156\ g \cdot mol^{-1}$ ✓
Molecular formula/*Molekulêre formule*: $C_{10}H_{20}O$ ✓ (2)
[21]

QUESTION 7/*VRAAG 7*

7.1 Exothermic/*Eksotermies* ✓
Reactants at higher energy than products./Products at lower energy than reactants./Energy is released./ΔH < 0. ✓
Reaktanse by hoër energie as produkte./Produkte by laer energie as reakanse./Enegie is vrygestel./ ΔH < 0. (2)

7.2
7.2.1 A ✓ (1)

7.2.2 A – B ✓ (1)

7.2.3 B – C ✓ (1)

7.3 1 mol $Ba(OH)_2$ releases/*stel* vry: 116 kJ ✓
0,18 mol $Ba(OH)_2$ releases/ *stel* vry: 0,18 x 116 ✓ = 20,88 kJ ✓
(Accept answers in range/*Aanvaar antwoorde in gebied*: 20,3 – 20,88 kJ) (3)
[8]

QUESTION 8/*VRAAG 8*

8.1 An acid is a proton donor. ✓✓
'n Suur is 'n protondonor/protonskenker. (2)

8.2
8.2.1 SO_4^{2-} (aq) ✓ (1)

8.2.3 H_2SO_4(aq) ✓ (1)

8.2.3 HSO_4^-(aq) ✓ (1)

8.3
8.3.1 Neutralisation / *Neutralisasie* ✓ (1)

8.3.2 H_2SO_4(aq) + KOH(aq) ✓ → K_2SO_4(aq) + $2H_2O$(ℓ) ✓ Bal. ✓

Notes/*Aantekeninge:*
- Reactants ✓ *Reaktanse* Products ✓ *Produkte* Balancing: ✓ *Balansering*
- Ignore double arrows. / *Ignoreer dubbelpyle.*
- Marking rule 6.3.10. / *Nasienreël 6.3.10.*

(3)

8.3.3 Blue ✓to yellow ✓
Blou na geel (2)

8.3.4 Potassium sulphate / *Kaliumsulfaat* ✓ (1)
[12]

QUESTION 9/*VRAAG 9*

9.1

9.1.1 Oxidation is an <u>increase in oxidation number</u>.✓✓
Oksidasie is 'n <u>toename in oksidasiegetal</u>. (2)

9.1.2 2Cr + 7O = -2
2Cr + (-14) = 2
Cr = +6 ✓ (1)

9.1.3 2H + 2O = 0
2 + 2O = 0
O = -1 ✓ (1)

9.2

9.2.1 A reducing agent <u>loses/donates electrons</u>. ✓✓
'n Reduseermiddel verloor/skenk elektrone. (2)

9.2.2 $Fe^{2+}(aq)$ ✓ (1)

9.2.3 $C\ell_2(g)$ ✓ (1)

9.2.4 $C\ell_2(g) + 2e^- \rightarrow 2C\ell^-$ ✓✓

<u>Marking guidelines/*Nasienriglyne:*</u>

- $C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$ $\frac{1}{2}$ $2C\ell^- \rightleftharpoons C\ell_2 + 2e^-$ $\frac{0}{2}$
- $2C\ell^- \leftarrow C\ell_2 + 2e^-$ $\frac{2}{2}$ $2C\ell^- \rightarrow C\ell_2 + 2e^-$ $\frac{0}{2}$

(2)

9.2.5 $Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e^-$ ✓✓

<u>Marking guidelines/*Nasienriglyne:*</u>

- $Fe^{2+} \rightleftharpoons Fe^{3+} + e^-$ $\frac{1}{2}$ $Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$ $\frac{0}{2}$
- $Fe^{3+} + e^- \leftarrow Fe^{2+}$ $\frac{2}{2}$ $Fe^{3+} + e^- \rightarrow Fe^{2+}$ $\frac{0}{2}$

(2)

9.2.6 $2Fe^{2+}(aq) + C\ell_2(g) \rightarrow 2Fe^{3+}(aq) + 2C\ell^-$ ✓✓

<u>Notes/*Aantekeninge:*</u>

- Ignore double arrows./*Ignoreer dubbelpyle.*

(2)
[14]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 Remove impurities/*Verwyder onsuiwerhede* ✓ (1)

10.1.2 Reducing agent/Formation of CO or CO_2 ✓
Reduseermiddel/Vorming van CO of CO_2 (1)

10.2

10.2.1 (Hot) air/*(Warm) lug* ✓ (1)

10.2.2 Molten iron/pig iron/Fe(ℓ) ✓
Gesmelte yster/ru-yster/Fe(ℓ) (1)

10.2.3 Slag/$CaSiO_3$/*metaalskuim* ✓ (1)

10.3 Carbon monoxide/carbon dioxide/nitrogen monoxide/nitrogen dioxide/nitrogen/sulphur dioxide ✓
Koolstofmonoksied/Koolstofdioksied/stikstofmonoksied/stikstofdioksied/swawel-dioksied (1)

10.4

10.4.1 Reducing agent/*Reduseermiddel* ✓ (1)

10.4.2 Fe_2O_3 ✓ (1)
[8]

TOTAL/*TOTAAL*: 150