MEMORANDUM

PHYSICAL SCIENCES/FISIESE WETENSKAPPE AUGUST 2019

CW PLC COMMON PAPER 2/GEMEENSKAPLIKE VRAESTEL 2

QUESTION 1

1.1 C✓✓ (2)

1.2 D✓✓ (2)

1.3 D✓✓ (2)

1.4 D✓✓ (2)

1.5 C✓✓ (2)

1.6 C✓✓ (2)

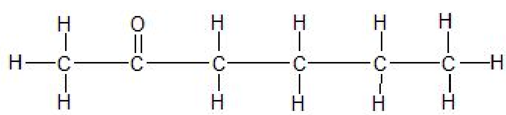
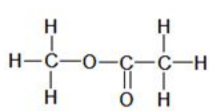
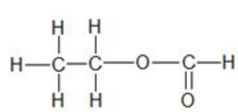
1.7 A✓✓ (2)

1.8 B✓✓ (2)

1.9 A✓✓ (2)

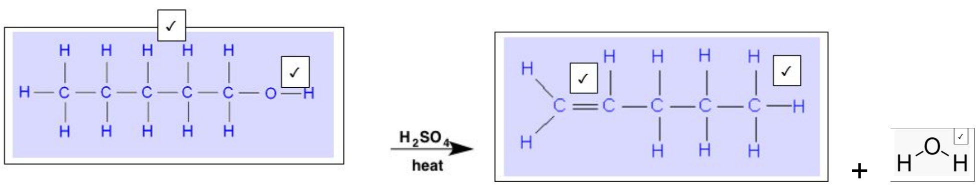
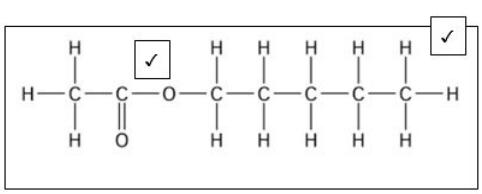
1.10 A✓✓ (2)

[20]

QUESTION 2			
2.1	2.1.1	A ✓	(1)
	2.1.2	D ✓	(1)
	2.1.3	C ✓	(1)
	2.1.4	E ✓	(1)
2.2	2.2.1	3-methyl✓ hex-1-yn✓ / 3-metielheks-1-yn	(2)
	2.2.2	 **<u>Notes/*Aantekeninge*</u>** Functional group: ✓ Whole structure correct: ✓ *Funksionele groep: ✓* *Hele struktuur korrek: ✓*	(2)
	2.2.3	Hept ✓-1-ene ✓ / hept-1-een	(2)
	2.2.4	Compounds with the same molecular formula ✓, but different structural formulae ✓./Verbindings met dieselfde molekulêre formule, maar verskillende struktuurformules.	(2)
	2.2.5	 OR  **<u>Notes/*Aantekeninge*</u>** Functional group: ✓ Whole structure correct: ✓ *Funksionele groep: ✓* *Hele struktuur korrek: ✓*	(2)
	2.2.6	Propan-2-ol (Correct position of functional group ✓/full name correct ✓) (Except/aanvaar 2-propanol)	(2)
			[16]

QUESTION 3			
3.1	A = Alcohols/ Alkohole ✓		(1)
3.2	What is the relationship between type of organic compound/ homologous series/ functional group and the boiling point of a substance? Wat is die verband tussen die tipe organiese verbinding/ homoloë reeks/ funksionele groep en die kookpunt van 'n stof? • must be a question/ moet vraag wees ✓ • moet afhanklik en onafhankilike veranderlikes bevat/ must contain independent and dependent variable. ✓		(2)
3.3	3.3.1	Boiling point/ Kookpunt ✓	(1)
	3.3.2	Homologous series/Functional group ✓ Homoloë reeks/Funksionele groep	(1)
3.4	Propanal/Propanaal ✓		(1)
3.5	• Compound A is an alcohol and contains London forces as well as <u>hydrogen bonds</u> between molecules. ✓ Verbinding A is 'n alkohol en bevat Londonkragte sowel as <u>waterstofbinding</u> tussen die molekules. • Compound B only contains <u>London forces</u>✓ Verbinding B bevat slegs <u>*Londonkragte*</u>. • <u>Hydrogen bonds are much stronger than London forces</u>,✓ OR therefore <u>more energy is needed</u> to overcome the IMF between alcohol molecules <u>Waterstofbinding is baie sterker as Londonkragte</u>, OF dus word <u>meer energie benodig</u> om die IMK tussen alkohol molekules te oorkom en • therefore A has a higher boiling point ✓ daarom het A 'n hoër kookpunt		(4)
3.6	B ✓ B has the lowest boiling point/ B het laagste kookpunt ✓ weakest IMF/swakste IMK		(2)
3.7	Only one independent variable / similar molecular masses ✓		

	Slegs een onafhanklike veranderlike / vergelykbare molekulêre massas		(1)
			[13]

QUESTION 4			
4.1	Primary/Primêre✓		(1)
4.2	4.2.1	Elimination/Eliminasie/Dehydration/Dehidrasie✓	(1)
	4.2.2	 Functional group/*Funksionele groep:* ✓ Whole structure correct/*Hele struktuur korrek:* ✓ **Notes/*Aantekeninge:*** • Accept -OH as condensed in structural formula. *Aanvaar -OH as gekondenseerd in struktuurformule.* • Accept H_2O as condensed or any shape. *Aanvaar H_2O as gekondenseerd of enige vorm.* • **Condensed/semistructural formulae** or mixture of both: Max. $\frac{4}{5}$ ***Gekondenseerde/semistruktuurformules*** *of mengsel van beide:* *Maks.* $\frac{4}{5}$ • **Molecular formula** for all structures, e.g. $C_4H_{10}O$: Max. $\frac{1}{5}$ ***Molekulêre formules*** *vir alle strukture, bv.* $C_4H_{10}O$: *Maks.* $\frac{1}{5}$ • Any additional reactants or products: Max. $\frac{4}{5}$ *Enige addisionele reaktanse of produkte:* *Maks.* $\frac{4}{5}$ • Everything correct, **wrong balancing:** Max. $\frac{4}{5}$ *Alles korrek,* ***verkeerde balansering:*** *Maks.* $\frac{4}{5}$	(5)
4.3	4.3.1	Esterification/(Acid catalysed) Condensation✓ Esterifikasie/(Suur gekataliseerde) Kondensasie	(1)
	4.3.2	 **Notes/*Aantekeninge*** Functional group: ✓ Whole structure correct: ✓ *Funksionele groep:* ✓ *Hele struktuur korrek:* ✓	

		Notes/*Aantekeninge*: • Condensed or semistructural formula: $\frac{1}{2}$ *Gekondenseerde of semistruktuurformule*: $\frac{1}{2}$ • Molecular formula/*Molekulêre formule*: $\frac{0}{2}$	(2)
4.4	4.4.1	Substitution/ Substitusie✓	(1)
	4.4.2	1-bromo✓pentane✓ / 1-bromopentaan	(2)
			[13]

QUESTION 5		
5.1	Exothermic /*Eksotermies* ✓ $\Delta H < 0$ / Energy is released. / Energie word vrygestel.✓	(2)

<table>
<tr><td>5.2</td><td>5.2.1</td><td>

<table>
<tr><td>

<u>OPTION 1/OPSIE 1</u>
$n(HC\ell) = cV$
$= (1{,}5)\checkmark\ (30 \times 10^{-3})\checkmark$
$= 0{,}045$ mol
ave rate / *gem. tempo* $= -\frac{\Delta n}{\Delta t}$
$= -\frac{(0 - 0{,}045)\checkmark}{(60 - 0)\checkmark}$
$= 7{,}5 \times 10^{-4}\ (mol \cdot s^{-1})\checkmark$

</td><td>

<u>Notes/Aantekeninge</u>
Accept /*Aanvaar:*
• $-7{,}5 \times 10^{-4}\ mol \cdot s^{-1}$
• Rate / *Tempo* $= \frac{\Delta n}{\Delta t}$
$= \frac{0{,}045 - 0}{60 - 0}$
$= 7{,}5 \times 10^{-4}\ (mol \cdot s^{-1})$

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<u>OPTION 2/OPSIE</u>
average / gem. tempo $= -\frac{\Delta c}{\Delta t}$
$= -\frac{(0 - 1{,}5)\checkmark}{(60 - 0)\checkmark}$
$= 0{,}025\ mol \cdot dm^{-3} \cdot s^{-1}$
$\therefore$ average rate $= (0{,}025)(30 \times 10^{-3})\checkmark\checkmark$
$= 7{,}5 \times 10^{-4}\ (mol \cdot s^{-1})\checkmark$

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<u>Notes/Aantekeninge</u>
Accept/*Aanvaar:*
• $-7{,}5 \times 10^{-4}\ mol \cdot s^{-1}$
• Rate / *Tempo* $= \frac{\Delta c}{\Delta t}$
$= \frac{1{,}5 - 0}{60 - 0}$
$= 0{,}025\ mol \cdot dm^{-3} \cdot s^{-1}$
average rate $= (0{,}025)(30 \times 10^{-3})$
$= 7{,}5 \times 10^{-4}\ (mol \cdot s^{-1})$

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<u>IF/INDIEN</u>
Mass of Mg used to calculate number of moles:/ *Massa van Mg gebruik om aantal mol te bereken:* Max./*Maks.* $\frac{2}{5}$
$n(HC\ell) = \frac{m}{M} = \frac{5}{24} = 0{,}21$ mol
ave rate / *gem. tempo* $= -\frac{\Delta n}{\Delta t}$
$= -\frac{(0 - 0{,}21)\checkmark}{(60 - 0)\checkmark}$
$= 3{,}5 \times 10^{-3}\ (mol \cdot s^{-1})$

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</td><td>(5)</td></tr>
<tr><td></td><td>5.2.2
(a)</td><td>

Increases/*Vermeerder* ✓
• The reaction is <u>exothermic</u>, resulting in an <u>increase in temperature</u>. ✓
Die reaksie is eksotermies wat tot toename in temperatuur lei.
• <u>More molecules have enough/</u>sufficient <u>kinetic energy</u>. ✓
<u>Meer molekule het genoeg</u>/voldoende <u>kinetiese energie</u>.
• <u>More effective collisions per unit time</u>/second. ✓
<u>Meer effektiewe botsings per eenheidtyd</u>/sekonde.

</td><td>(4)</td></tr>
</table>

	(b)	Decreases/*Verminder* ✓ Concentration (of acid) decreases./*Konsentrasie (van suur) verminder.* ✓ **OR/*OF*** The surface area of magnesium decreases./ *Die reaksieoppervlak van magnesium verminder.* **OR/*OF*** Reactants are being used up./*Reaktanse word opgebruik.*	(2)
5.3	**<u>ANY TWO/*ENIGE TWEE*</u>** • <u>Higher temperature</u>/*Hoër temperatuur* ✓ • <u>Larger surface area/</u>state of division/contact area of Mg/Use magnesium powder ✓ *<u>Groter reaksie-oppervlak/toestand van verdeeldheid/kontakoppervlak van magnesium</u>* • Addition of a catalyst./*Byvoeging van katalisator.*		(2)
			[15]

QUESTION 6

6.1

6.1.1 *Chemical equilibrium* is a dynamic equilibrium when <u>the rate of the forward reaction equals the rate of the reverse reaction</u>.✓✓ Chemiese ewewig is 'n dinamiese ewewig wanneer <u>die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie</u>. (2)

6.1.2

	CO	$2H_2$	CH_3OH
Initial mole	**x**	**8**	0
Moles used/produced	2,875	5,75✓	2,875✓
Moles at equilibrium	x – 2,875	2,25✓	2,875✓
$c_{eq} = \frac{n}{V}$ $V = 10dm^3$	$\frac{x - 2,875}{10}$	**0,225**	0,2875✓

$$K_c = \frac{[CH_3OH]}{[CO][H_2]^2} \checkmark$$

$$\checkmark 6,22 = \frac{(0,2875)}{[CO](0,225)^2} \checkmark$$

$$[CO] = \frac{(0,2875)}{(6,22)(0,225)^2}$$

$$[CO] = 0,91302$$

$$\frac{x-2,875}{10} = 0,91302$$

$$x = 12,01 \text{ or } 12 \checkmark$$

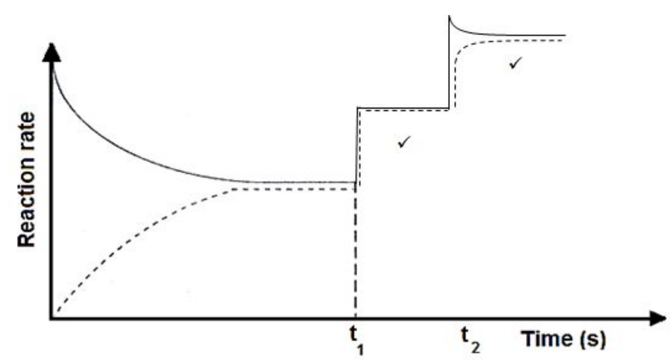
Marking criteria:

- Calculate $n(H_2)$ at equilibrium: 2,25 mol
- Calculate $n(H_2)$ used= $n_{initial}$ - n_{eq}
- Use ratio 1:2:1 for moles used/produced
- Calculate mole at equilibrium of CO and CH_3OH
- Divide n_{eq} by 10 dm^3
- Correct K_c expression
- Substitute 6,22 in K_c expression
- Substitute equilibrium concentrations in K_c expression
- Final answer: 12.01 or 12

(9)

6.2 *Le Chatelier's principle*: When the <u>equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium</u> ✓by <u>favouring the reaction that will oppose the disturbance</u>.✓ / Wanneer die <u>ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n nuwe ewewig wil herinstel</u> ✓deur die <u>reaksie wat die versteuring teenwerk te bevoordeel</u>.✓ (2)

6.3



6.3.1 One mark for the section from t_1 to t_2 correctly drawn (1)

6.3.2 One mark for the section from t_2 correctly drawn. (1)

[15]

QUESTION 7			
7.1	7.1.1	Ampholyte/ Amphiprotic (substance)✓ Amfoliet/Amfiprotiese (stof)	(1)
	7.1.2	H_2SO_4 ✓	(1)
7.2	7.2.1	Can only donate one proton/Kan slegs 1 proton skenk ✓	(1)
	7.2.2	$n(NaHCO_3) = \frac{m}{M}$ ✓ (One mark for $n(NaHCO_3) = \frac{m}{M}$ or $c(HCl) = \frac{n}{V}$) $= \frac{25}{84}$ ✓ $= 0{,}2976\ mol$ (0,2976190) ✓ $n(NaHCO_3) = n(HCl) = 0{,}2976\ mol$ ✓ $c(HCl) = \frac{n}{V}$ $5 = \frac{0{,}2976}{V}$ ✓ $V = 0{,}06\ dm^3$ ✓ **<u>Marking criteria/Nasienriglyne:</u>** ● Formula/Formule $n(NaHCO_3) = \frac{m}{M}$ or $c(HCl) = \frac{n}{V}$) ● Substitute/Vervang 25 g and/en 84 g.mol^{-1} in $n(NaHCO_3) = \frac{m}{M}$ ● $n(NaHCO_3)$ = 0,2976 (mol) or (0,297619) ● Use mole ratio (1:1) to determine n(HCℓ)/Gebruik die molverhouding om die n(HCl) te bepaal ● Substitute/Vervang c(HCℓ) = 5 (mol.dm^{-3}) in $c(HCl) = \frac{n}{V}$) ● Answer/Antwoord: V(HCℓ) = 0,06 dm^3	(6)
	7.2.3	Contain a small amount (number of moles) of acid in proportion to the volume of water ✓✓ Bevat 'n klein hoeveelheid (aantal mol) suur in verhouding met volume water.	(2)

7.3	7.3.1	Burette/Buret ✓	(1)
	7.3.2	$n_a(initial) = c_aV_a$ $= (0{,}3)(25 \times 10^{-3})$ ✓ $= 7{,}5 \times 10^{-3} mol$ $n_b(reacted) = c_bV_b$ $= (0{,}2)(30 \times 10^{-3})$ ✓ $= 6{,}0 \times 10^{-3} mol$ $\frac{n_a}{n_b} = \frac{1}{1}$ $n_a(neutralised) = n_b = 6{,}0 \times 10^{-3} mol$ ✓ $n_a(left) = n_a(initial) - n_a(neutralised)$ $= (7{,}5 \times 10^{-3}) - (6{,}0 \times 10^{-3})$ ✓ $= 1{,}5 \times 10^{-3}\ mol$ $c_a = \frac{n}{V}$ $= \frac{1{,}5 \times 10^{-3}}{(25 \times 10^{-3}) + (30 \times 10^{-3})}$ ✓ $= 0{,}0273\ mol.dm^{-3}$ $pH = -\log[H_3O^+]$ ✓ $= -\log(0{,}0273)$ ✓ $= 1{,}56$ ✓ **Marking criteria:** • Substitute initial [acid] and volume • Substitute initial [base] and volume • Use ratio 1:1 • Initial mole acid – mole acid reacted • Substitute volume acid + volume base • pH formula • Substitute ca in pH formula • Final answer: **Nasienriglyne:** • Vervang aanvanklike [suur] en volume • Vervang aanvanklike [basis] en volume • Gebruik verhouding 1:1 • Aanvanklike mol suur – mol suur gereageer • Vervang volume suur + volume basis • pH formule • Vervang ca in pH formule • Finale antwoord:	(8)
	7.3.3	Equal to 7/Gelyk aan 7. ✓ Strong acid and strong base/No hydrolysis of the salt. ✓ Sterk suur en sterk basis/Geen hidrolise van die sout nie.	(2)
			[22]

QUESTION 8			
8.1	8.1.1	Magnesium becomes smaller./Brown solid forms/Mg disappears/eaten away/Mg changes colour.✓ Magnesium word kleiner./Bruin vaste stof vorm/Mg verdwyn/ weggevreet/Mg verander van kleur.	(1)
	8.1.2	Cu^{2+} is a stronger oxidising agent (than Mg^{2+})✓ and will be reduced to Cu.✓ Cu^{2+} is 'n sterker oksideermiddel (as Mg^{2+}) en sal na Cu gereduseer word. OR/OF Mg is a stronger reducing agent (than Cu) and will reduceCu^{2+} to Cu. Mg is 'n sterker reduseermiddel (as Cu) en sal Cu^{2+} na Cu reduseer.	(2)
8.2	8.2.1	a) Aℓ (aluminium) ✓	(1)
	8.1.2	b) $NiC\ell_2$ (aq) or nickel chloride✓ / nikkelchloried	(1)
	8.2.2	1 $mol \cdot dm^{-3}$ ✓	(1)
	8.2.3	Na^+ ✓	(1)
	8.2.4	$Ni^{2+} + 2e^- \rightarrow Ni$ ✓✓	(2)
	8.2.5	$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$✓ (Any correct formula) $= -0,27$✓ $- (-1,66$✓$)$ $= +1,39V$ ✓	(4)
	8.2.6	Increase / Neem toe ✓	(1)
	8.2.7	DECREASE , ✓ As the $[A\ell^{3+}]$ increases, the reverse reaction in the Aℓ | $A\ell^{3+}$ half cell: $A\ell \rightleftharpoons A\ell^{3+} + 3e^-$ is favoured. ✓OR (The tendency of the net reaction $A\ell + Ni^{2+} \rightarrow A\ell^{3+} + Ni$ to proceed from left to right is reduced) This lowers the electrode potential of Aℓ | $A\ell^{3+}$ half cell, ✓ resulting in a lower cell potential. NEEM AF✓ Die terugwaartse reaksie in die Aℓ | $A\ell^{3+}$ halfsel : $A\ell \rightleftharpoons A\ell^{3+} + 3e^-$ word bevoordeel.✓ /(Die tendens van die netto reaksie $A\ell + Ni^{2+} \rightarrow A\ell^{3+}$ + Ni om van links na regs voort te gaan verminder). Die elektrode potensiaal van die Aℓ | $A\ell^{3+}$ halfsel verminder,✓ wat 'n vermindering van die selpotensiaal veroorsaak	(3)
			[17]

QUESTION 9		
9.1	Electrical✓ energy to Chemical energy✓ Elektriese energie na Chemiese energie	(2)
9.2	Cathode/Katode✓ Reduction✓ must take place to deposit Silver metal on the dummy.✓ Reduksie moet plaasvind om die fopspeen met Silwer metaal te bedek.	(3)
9.3	Ag/Silver✓ Ag/Silwer	(1)
9.4	$Ag^+ + e^- \rightarrow Ag$✓✓	(2)
9.5	$AgNO_3$ ✓or CH_3COOAg (Not insoluble AgCl)	(1)
9.6	Plastic cannot conduct electricity/Plastiek kan nie elektrisiteit gelei nie. ✓	(1)
		[10]

QUESTION 10			
10.1	10.1.1	X - Haber Process/Haber Proses✓ Y - Contact Process/Kontak Proses✓	(2)
	10.1.2	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ reactants✓ products✓ balancing✓	(3)
10.2	$m(fertiliser) = \frac{36}{100} \times 20$ ✓ $m(fertiliser) = 7.2kg$ $\%N = \frac{4,11}{7,2} \times 100 = 57,08\%$ ✓ $\%P = \frac{0,51}{7.2} \times 100 = 7,08\%$ $\%K = 100 - 57,08 - 7,08 = 35,84\%$ ✓ N : P : K 57,08 : 7,08 : 35,84 8,06 : 1 : 5,06 8 : 1 : 5 ✓ **Marking criteria:** ● Calculate mass of pure fertiliser: $\frac{36}{100} \times 20$ or $7.2(kg)$ ● Divide mass of N and P by 7,2(kg) and multiply by 100 ● Calculate %K= 35,84% ● Correct NPK ratio 8 : 1: 5 **Nasienriglyne:** ● Bereken die massa suiwer kunsmistof: $\frac{36}{100} \times 20$ or $7.2(kg)$ ● Deel die massa van N en P deur 7,2(kg) en vermenigvuldig met 100 ● Bereken %K= 35,84% ● Korrekte NPK verhouding 8 : 1 : 5		(4)
			[9]

TOTAAL: 150