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)

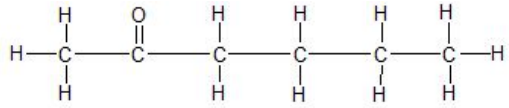
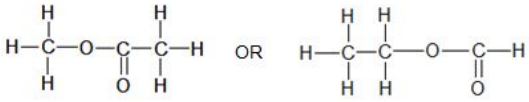
1.7 A✓ ✓ (2)

1.8 B✓ ✓ (2)

1.9 A✓ ✓ (2)

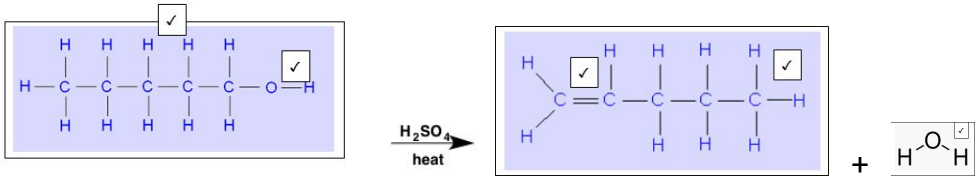
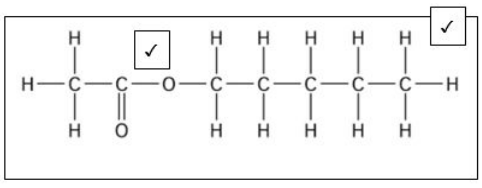
1.10 A✓ ✓ (2)

[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	 **Notes/*Aantekeninge*** 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 **Notes/*Aantekeninge*** 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 hydrogen bonds between molecules. ✓ Verbinding A is 'n alkohol en bevat Londonkragte sowel as waterstofbinding tussen die molekules. ● Compound B only contains London forces ✓ Verbinding B bevat slegs *Londonkragte*. ● Hydrogen bonds are much stronger than London forces, ✓ OR therefore more energy is needed to overcome the IMF between alcohol molecules Waterstofbinding is baie sterker as Londonkragte, OF dus word meer energie benodig 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		(5)
4.3	4.3.1	Esterification/(Acid catalysed) Condensation✓ Esterifikasie/(Suur gekataliseerde) Kondensasie	(1)
	4.3.2		

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.* $\frac{4}{5}$

Notes/*Aantekeninge*
Functional group: ✓
Whole structure correct: ✓

Funksionele groep: ✓
Hele struktuur korrek: ✓

		Notes/*Aantekeninge*: • Condensed or semistructural formula: ½ *Gekondenseerde of semistruktuurformule*: ½ • Molecular formula/*Molekulêre formule*: 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)

5.2	5.2.1	**OPTION 1/*OPSIE 1*** $n(HC\ell) = cV$ $= (1,5)$ ✓ (30×10^{-3}) ✓ $= 0,045$ mol ave rate / *gem. tempo* $= -\frac{\Delta n}{\Delta t}$ $= -\frac{(0 - 0,045)}{(60 - 0)}$ ✓ $= 7,5 \times 10^{-4}$ (mol · s^{-1}) ✓ **Notes/*Aantekeninge*** **Accept /*Aanvaar:*** • $-7,5 \times 10^{-4}$ mol·s^{-1} • Rate / *Tempo* $= \frac{\Delta n}{\Delta t}$ $= \frac{0,045 - 0}{60 - 0}$ $= 7,5 \times 10^{-4}$ (mol·s^{-1}) **OPTION 2/*OPSIE*** average / gem. tempo $= -\frac{\Delta c}{\Delta t}$ $= -\frac{(0 - 1,5)}{(60 - 0)}$ ✓ $= 0,025$ mol · dm^{-3} · s^{-1} ∴ average rate $= (0,025)(30 \times 10^{-3})$ ✓✓ $= 7,5 \times 10^{-4}$ (mol·s^{-1}) ✓ **Notes/*Aantekeninge*** **Accept/*Aanvaar:*** • $-7,5 \times 10^{-4}$ mol·s^{-1} • Rate / *Tempo* $= \frac{\Delta c}{\Delta t}$ $= \frac{1,5 - 0}{60 - 0}$ $= 0,025$ mol · dm^{-3} · s^{-1} average rate$=(0,025)(30 \times 10^{-3})$ $= 7,5 \times 10^{-4}$ (mol·s^{-1}) **IF/*INDIEN*** 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* $= -\frac{\Delta n}{\Delta t}$ $= -\frac{(0 - 0,21)}{(60 - 0)}$ ✓ $= 3,5 \times 10^{-3}$ (mol · s^{-1})	(5)
	5.2.2 (a)	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.*	(4)

	(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	**ANY TWO/*ENIGE TWEE***	• Higher temperature/*Hoër temperatuur* ✓ • Larger surface area/state of division/contact area of Mg/Use magnesium powder ✓ *Groter reaksie-oppervlak/toestand van verdeeldheid/kontakoppervlak van magnesium* • Addition of a catalyst./*Byvoeging van katalisator.*	(2)
			[15]

QUESTION 6

6.1 6.1.1 *Chemical equilibrium* is a dynamic equilibrium when the rate of the forward reaction equals the rate of the reverse reaction.✓✓ Chemiese ewewig is 'n dinamiese ewewig wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. (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✓

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

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

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

$[CO] = 0,91302$

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

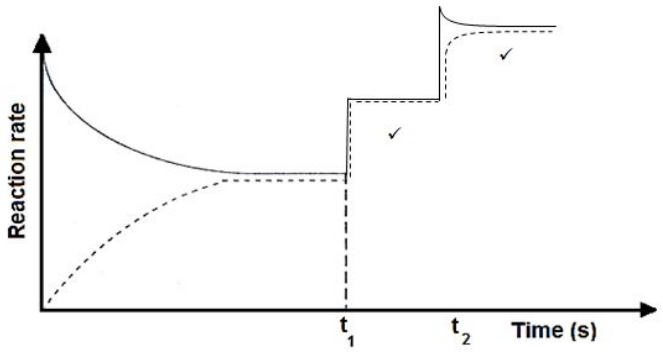
$x = 12,01 \text{ or } 12$ ✓

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 equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium ✓by favouring the reaction that will oppose the disturbance.✓ / Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n nuwe ewewig wil herinstel ✓deur die reaksie wat die versteuring teenwerk te bevoordeel.✓ (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	$n_a(initial) = c_a V_a$ $= (0{,}3)(25 \times 10^{-3})$ ✓ $= 7{,}5 \times 10^{-3} mol$ $n_b(reacted) = c_b V_b$ $= (0{,}2)(30 \times 10^{-3})$ ✓ $= 6{,}0 \times 10^{-3} mol$ $\frac{n_a}{n_b} = \frac{1}{1}$ $n_a(neutralised) = n_b = 6{,}0 \times 10^{-3} mol$ ✓ $n_a(left) = n_a(initial) - n_a(neutralised)$ $= (7{,}5 \times 10^{-3}) - (6{,}0 \times 10^{-3})$ ✓ $= 1{,}5 \times 10^{-3}\ mol$ $c_a = \frac{n}{V}$ $= \frac{1{,}5 \times 10^{-3}}{(25 \times 10^{-3}) + (30 \times 10^{-3})}$ ✓ $= 0{,}0273\ mol.dm^{-3}$ $pH = -\log[H_3O^+]$ ✓ $= -\log(0{,}0273)$ ✓ $= 1{,}56$ ✓ **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·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: $A\ell \leftrightharpoons A\ell^{3+} + 3e^-$ 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 : $A\ell \leftrightharpoons A\ell^{3+} + 3e^-$ 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