education

DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

SEPTEMBER 2016

MEMORANDUM

MARKS: 150

TIME: 3 hours

This memoranda consists of 15 pages

GENERAL GUIDELINES

1 CALCULATIONS

1.1 **Marks will be awarded for:** correct formula, correct substitution, and correct answer with unit.

1.2 **NO marks** will be awarded if an **Incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.

1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.

1.4 If **no formula** is given, but **all substitutions are correct**, a candidate will **forfeit one mark.**

Example:

No K_c expression, correct substitution

$K_C = \frac{(2)^2}{(2)(1)^3}$ ✓ = 2 ✓ $(\frac{2}{3})$

1.5 Marks are only awarded for a formula if a **calculation has been attempted** i.e. substitution have been made or a numerical answer given.

1.6 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.

1.7 All calculations, when not specified in the question, must be done to two decimal places.

1.8 If a final answer to a calculation is correct, full marks will not automatically be awarded. Marks will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.

2 UNITS

2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.

2.2 Units are only required in the final answer to a calculation.

2.3 Marks are only awarded for an answer and not for a unit *per se.* Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:

- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

2.4 Separate compound units with a multiplication dot, not a full stop, for example, $mol{\cdot}dm^{-3}$. Accept $mol.dm^{-3}$ (mol/dm^3) for marking purpose.

3 If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.

3.1 When a chemical **FORMULA** is asked, and the **NAME** is given as answer the candidate forfeits the marks. The same rule applies when the **NAME** is asked and the **FORMULA** is given.

3.2 When redox half- reactions are to be written, the correct arrow should be used.

If the equation

$H_2S \rightarrow S + H^+ + 2e^-$ $(^2/_2)$

Is the correct answer, the marks must be given as follows:

$H_2S \rightleftharpoons S + H^+ + 2e^-$ $(^1/_2)$

$H_2S \leftarrow S + 2H^+ + 2e^-$ $(^0/_2)$

$S + 2H^+ + 2e^- \leftarrow H_2S$ $(^2/_2)$

$S + 2H^+ + 2e^- \rightleftharpoons H_2S$ $(^0/_2)$

3.4 One mark is forfeited when the charge of an ion is omitted per equation. (not for the charge on an electron)

3.6 The error carrying principle does not apply to chemical equations or half reactions. For example, if a learner writes the wrong oxidation/reduction half-reaction in the sub-question and carries the answer over to another sub-question (balancing of equations or calculation of E°_{cell}) then the learner must not be credited for this substitution.

3.7 In the structural formula of an organic molecule all hydrogen atoms must be shown. Marks must be deducted if hydrogen atoms are omitted.

When a structural formula is asked, marks must be deducted if the learner writes the condensed formula.

3.8 When an IUPAC name is asked and candidate omits the hyphen (e.g. instead of pent-1-ene or 1-pentene the candidate writes pent 1 ene or 1 pentene), marks must be forfeited.

3.9 When a chemical reaction is asked, marks are awarded for correct reactants, correct products and correct balancing.

If only a reactant(s) followed by an arrow, or only a product(s) preceded by an arrow, is/are written, marks may be awarded for the reactant(s) or products(s). if only a reactant(s) or only a product(s) are written, without an arrow, no marks are awarded for the reactants(s) or product(s).

Examples: $N_2 + 3H_2$ ✓ $\rightarrow$ $2NH_3$ ✓ bal. ✓	
$N_2 + H_2\rightarrow$ ✓	$^1/_3$
$\rightarrow NH_3$ ✓	$^1/_3$
$N_2 + H_2$	$^0/_3$
NH_3	$^0/_3$

4 **POSITIVE MARKING**

4.1 **Sub-question to sub-question:**

When a certain variable is calculated in one sub-question (e.g. 3.1) and needs to be substituted in another (3.2 or 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3 **full marks** are to be awarded for the subsequent sub-question.

4.2 **A multi-step question:** if the candidate has to calculate, for example, current in the first and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.

5 NEGATIVE MARKING

Normally an incorrect answer cannot be correctly motivated if on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given to QUESTION 3.2. However, if the answer for e.g. 3.1 is based on a calculation, the motivation for the incorrect answer in 3.2 could be considered.

QUESTION 1 / *VRAAG 1*

1.1 C✓✓ (2)

1.2 B✓✓ (2)

1.3 C✓✓ (2)

1.4 B✓✓ (2)

1.5 D✓✓ (2)

1.6 C✓✓ (2)

1.7 A✓✓ (2)

1.8 D✓✓ (2)

1.9 B✓✓ (2)

1.10 A✓✓ (2)

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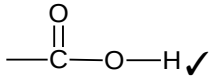
QUESTION 2 / *VRAAG 2*

2.1.1 C ✓ (1)

2.1.2  (1)

2.1.3 3-methyl✓propanal✓/*3-metielpropanaal* (2)

2.1.4 E✓ (1)

2.1.5 D ✓ and F ✓ (2)

2.1.6 alkyne ✓ (1)

2.1.7 UNSATURATED /*ONVERSADIG* ✓
There are multiple bonds✓ between the carbon atoms ✓/*Daar is meervoudige bindings tussen die koolstofatome*
OR
The carbon atom is not bonded to a maximum number of atoms / *Die koolstofatoom is nie aan die maksimum aantal atome gebind nie* (3)

2.2.1 Distinct/pleasant aroma smell ✓ /*Aangename geur* (1)

2.2.2 Ethanol/*Etanol*✓✓ (2)

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QUESTION 3 / *VRAAG 3*

3.1 The temperature at which the vapour ✓ pressure of the substance is equal to the atmospheric pressure. ✓
Die temperatuur waar die dampdruk gelyk is aan die omliggende atmosferiese druk. (2)

3.2 The more branched an alkane , the lower the boiling point. ✓ ✓
Hoe meer vertak 'n alkaan is, hoe laer word die kookpunt.
Criteria
Independent and dependent variable has to be mentioned in the hypothesis. (2)

3.3 Pentane has no branches/is a straight chain hydrocarbon. ✓
It has the largest surface area. ✓
The London forces/ Dispersion forces/induced dipole forces are the strongest✓
More energy is needed to overcome the intermolecular forces✓, therefor it has the highest boiling point.
Pentaan het geen vertakkings nie.
Dit het die grootste kontakoppervlakte.
Die Londonkragte/dispersiekragte/geïnduseerde dipoolkragte is die sterktste.
Meer energie word benodig om die intermolekulêre kragte te oorkom.
Die kookpunt is dus die hoogste. (4)

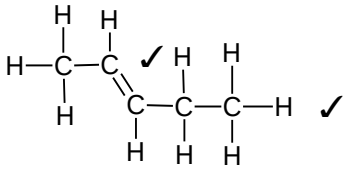
3.4 2,2-dimethylpropane✓ It has the lowest boiling point ✓/
2,2-dimetielpropaan. Dit het die laagste kookpunt. (2)

3.5 $2\ C_5H_{12} + 8\ O_2$ ✓ → $5\ CO_2 + 6\ H_2O$ ✓ (*bal* ✓)
Accept multiples*/Aanvaar veelvoude* (3)
[13]

QUESTION 4 / *VRAAG 4*

4.1.1 Heat ✓/*Hitte* (1)

4.1.2 Elimination✓ / Dehydrohalogenation/debromonation
Eliminasie/Dehidrohalogenering (1)

4.1.3  ✓

Functional group ✓/*Funksionele groep*
Whole structure correct ✓ (2)

4.1.4 Water ✓or dilute sodium hydroxide /*Water of verdunde natriumhidroksied* (1)

4.1.5 Substitution / Hydrolysis /*Substitusie/hidrolise* ✓ (1)

4.1.6 Elimination/ Dehydration /*Dehidrasie* ✓ (1)

4.2.1 Esterification/ *Esterifikasie* ✓ (1)

4.2.2 Sulphuric acid / *swawelsuur* H_2SO_4 ✓ (1)

4.2.3 **OPTION1/OPSIE 1**

$n = \frac{m}{M}$ ✓

$= \frac{68}{74}$

0,92 mol ✓ ← 1 : 1 ✓ = 0,92 mol ✓

m = n x M = 0,92 x 46✓ = 42,32 g ✓

% : $\frac{42,32}{60} \times \frac{100}{1} = 70,53\%$

OPTION 2/OPSIE 2

$n = \frac{m}{M}$ ✓

$= \frac{68}{74}$

= 0,92 mol ✓

$\frac{n(C_3H_6O)}{n(C_3H_6O_2)} = \frac{1}{1}$

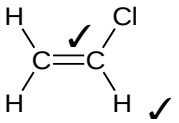
$n(C_3H_6O) = \frac{1}{1}$✓ (0,92)✓

=0,92 mol

m = n x M = 0,92 x 46✓ = 42,32 g

% : $\frac{42,32}{60} \times \frac{100}{1} = 70,53\%$ ✓

(6)

4.3.1 

✓ ✓ (2)

4.3.2 Addition ✓/*Addisie* (1)

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QUESTION 5 / *VRAAG 5*

5.1 The change in the concentration/mass/mol/volume of the reactants / products ✓ per unit time.✓
Die verandering in die konsentrasie van die reaktante/produkte per tydseenheid. (2)

5.2 The concentration of the acid.✓/*Die konsentrasie van die suur* (1)

5.3.1 Change in moles = 0,08 - 0,1 = -0,02 mol ✓

$\Delta m = \Delta n \times M$

$= -0,02 \times 65$ ✓

$= -1,3$ g ✓

Rate of reaction = $\frac{mass\ of\ Zn\ used}{time}$

$= \frac{-1,3}{60}$ ✓

$= 0,02\ g.s^{-1}$ ✓

OR

Change in moles = 0,1 – 0,08 = 0,02 mol ✓

Rate of reaction = $\frac{moles\ of\ Zn\ used}{time} = -\frac{0,02}{60}$ ✓

$= 3,33 \times 10^{-4} mol.s^{-1}$✓

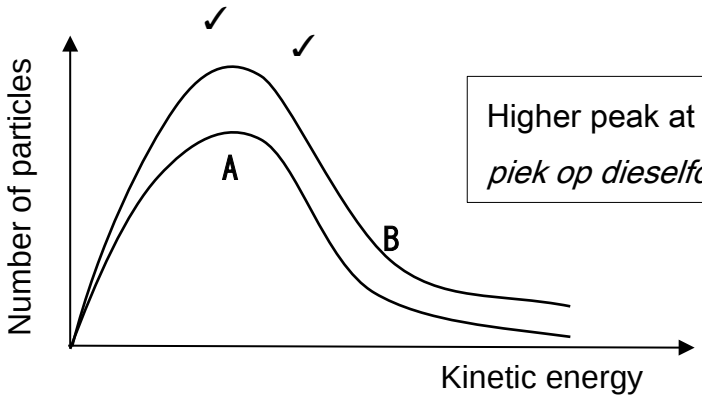
$= (3,33 \times 10^{-4} \times 65$✓$)\ g.s^{-1}$

$= 0,02\ g.s^{-1}$ ✓

(5)

5.3.2 Less than/*Kleiner* ✓ (1)

5.4



Higher peak at the same point/*Hoër piek op dieselfde punt* ✓✓

(2)

5.5 If we increase the concentration of the acid,
the number of moles increases. ✓
More effective collisions per second. ✓
Higher reaction rate. ✓
As die konsentrasie van die suur verhoog word,
neem die aantal mol deeltjies toe.
Meer effektiewe botsings per sekonde.
Hoër reaksietempo*.*

(3)

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QUESTION 6 / *VRAAG 6*

6.1 **CALCULATIONS USING NUMBER OF MOLES**

Mark allocation/*Puntetoekenning*

- USING ratio / *Gebruik die verhouding*: 1:1:1:1 ✓
- Equilibrium: n(CO_2) = 1.276 mol ;n(H_2) = 0,276 mol (initial - change) ✓
- Equilibrium: n(CO) = 0,724 mol; n(H_2O) = 0,724 mol (initial + change) ✓
- Divide by volume = 2,0 dm^3 ✓
- Correct K_c expression (formulae in square brackets) ✓
- Correct substitution in K_c expression ✓
- Final answer/*Finale antwoord*: 1,49 ✓

	CO_2	H_2	CO	H_2O
Initial moles	2	1	0,2	0
Moles used/reacted	-0,724	-0,724	+0,724 ✓	+0,724
Moles at equilibrium	1,276✓	0,276	0,924 ✓	0,724
[..] at equilibrium (mol·dm^{-3}) $c=\frac{n}{v}$	0,638	0, 138	0,462✓	0,362

$$K_C = \frac{[CO][H_2O]}{[CO_2][H_2]} \checkmark$$

$$K_C = \frac{(0,462)(0,362)}{(0,638)(0,138)} \checkmark$$

$$K_C = 1,49 \checkmark$$

CALCULATIONS USING CONCENTRATION

Mark allocation/*Puntetoekenning*

- Divide by volume = 2,0 dm^3 ✓
- USING ratio / *Gebruik die verhouding*: 1:1:1:1 ✓
- Equilibrium: [CO_2] = 1.276 mol/dm^3 ;[H_2] = 0,276 mol/dm^3 (initial - change✓
- Equilibrium: [CO] = 0,724 mol/dm^3; [H_2O] = 0,724 mol/dm^3(initial+change)✓
- Correct K_c expression (formulae in square brackets) ✓
- Correct substitution in K_c expression ✓
- Final answer/*Finale antwoord*: 1,49 ✓

	CO_2	H_2	CO	H_2O
Initial [ ]	1	0,5	0,1	0 ✓
[ ] used/reacted	$-0{,}362$	$-0{,}362$✓	$+0{,}362$ ✓	$+0.362$
Equilibrium [ ]	0,638	0,138	0,462 ✓	0,362

$$K_C = \frac{[CO][H_2O]}{[CO_2][H_2]} \checkmark$$

$$K_C = \frac{(0{,}462)(0{,}362)}{(0{,}638)(0{,}138)} \checkmark$$

$$K_C = 1{,}49 \checkmark$$

(7)

6.2 EXOTHERMIC ✓

If the Kc value decreases, it means that the concentration of the products decreases. ✓ The reverse reaction is favoured. According to Le Chatelier, the endothermic reaction will be favoured when the temperature is increased. ✓ The reverse reaction is endothermic. ✓The forward reaction is exothermic.

EKSOTERMIES

As die Kc waarde afneem, beteken dit dat die konsentrasie van die produkte afneem. Die terugwaartse reaksie word dus bevoordeel. Volgens Le Chatelier sal die endotermiese reaksie bevoordeel word as die temperatuur toeneem. Die terugwaartse reaksie is endotermies en dus is die voorwaartse reaksie eksotermies.

(4)

6.3.1 DECREASES/*AFNEEM* ✓ (1)

6.3.2 NEGATIVE MARKING
According to Le Chatelier, if the number of moles of water vapour is increased, the system will oppose the change by lowering ✓ the number of moles of water vapour. The reverse reaction is favoured. ✓ The concentration of the products decrease. ✓ (3)
As die aantal mol waterdamp verhoog word, sal volgens Le Chatelier, die sisteem die verandering teenweerk deur die aantal mol waterdamp te verlaag. Die terugwaartse reaksie word bevoordeel. Die konsentrasie van die produkte neem af.

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QUESTION 7 / *VRAAG 7*

7.1 A strong acid is an acid that ionizes completely in water ✓ to form a high concentration of H_3O^+ ions. (2)
'n Sterk suur ioniseer volledig in water.

7.2.1 Ampholyte ✓/*Amfoliet* (1)

7.2.2 $HSO_4^- + H_2O \rightleftharpoons H_3O^+ + SO_4^{2-}$ ✓✓ (2)

7.3 **OPTION 1 / *OPSIE 1***

$[OH^-] = 0,4 \text{ mol·dm}^{-3}$ ✓ *(ratio)*

$[H_3O^+][OH^-] = 1 \times 10^{-14}$ ✓

$[H_3O^+](0,4) = 1 \times 10^{-14}$

$[H_2O] = \frac{1 \times 10^{14}}{0,4}$

$= 2,5 \times 10^{-14} \text{ mol.dm}^{-3}$

$pH = -\log [H_3O^+]$ ✓

$= -\log (2,5 \times 10^{-14})$

$= 13,6$ ✓

OPTION 2

$[OH^-] = 0,4 \text{ mol·dm}^{-3}$ ✓ (ratio)

$pOH = -\log[OH^-]$ ✓ $= -\log(0,4) = 0,4$

$pH + pOH = 14$ ✓

$\therefore pH = 13,6$ ✓ (4)

7.4.1 $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

c = 0,309 mol·dm^{-3}
V = 0,01957 dm^{-3}

n_{NaOH} = c x V✓
= 0,309 x 0,01957
= 6,05 x 10^{-3} mol✓
m = n x $M_{CH3COOH}$ ✓
= (6,05 x 10^{-3}) x 60 ✓
= 0,363 g ✓ (5)

7.4.2 POSITIVE MARKING FROM 7.4.1
% = 0,363 / 10 x 100 = 3,63% ✓ Yes ✓ (2)

7.4.3 Phenolphtaleien✓ /*Fenolftaleïen*
Weak acid and strong base titration ✓ /*Swak suur en sterk basis titrasie.*
OR
pH of solution $\approx \frac{6+13}{2} \approx 9,5$ (2)

7.4.4 Hydrolysis ✓/ *Hidrolise* (1)

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QUESTION 8 / *VRAAG 8*

8.1 Concentration of electrolytes: 1 mol.dm^{-3} ✓
Pressure of gases: 1 atm / 101,3 kPa ✓ (2)

8.2 Pt is an inert electrode/very weak reducing agent ✓
Pt is 'n onaktiewe metal/Baie swak reduseermiddel

It is a (good) conductor of electricity ✓ /*Dit gelei elektrisiteit* (2)

8.3 $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ ✓✓ (2)

8.4 Fe(s) | Fe^{2+} (aq) or (1 mol.dm^{-3}) ✓ ||✓ O_2 (g) (1 atm) | H_2O (ℓ) | Pt(s)✓ (3)

8.5 $E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓
= 1,23✓ -(-0,44)✓
= 1,67 V✓ (4)

8.6 The cell reaction reaches equilibrium. ✓ /*Die selreaksie bereik ewewig.* (1)

[14]

QUESTION 9 / *VRAAG 9*

9.1 Cathode ✓/*Katode* (1)

9.2 A solution / liquid that conducts electricity through the movement of ions. ✓✓
'n Oplossing wat elektrisiteit gelei deur die beweging van vry ione.
OR
a substance whose aqueous solution contains ions OR a substance that dissolves in water to give a solution that conducts electricity (2)

9.3 Silver nitrate / $AgNO_3$ ✓ (1)
Accept any soluble Ag^+ salt /*Aanvaar enige oplosbare Ag^+ sout*

9.4 $Ag^+ + e^- \rightarrow Ag$ ✓✓ (2)

9.5 Remains the same./*Bly dieselfde* ✓ (1)

9.6 The rate at which the Ag^+ ions is reduced, is equal to the rate at which the Ag is oxidised. ✓✓
Die tempo waarteen die Ag^+ ione gereduseer word, is gelyk aan die tempo waarteen die Ag geoksideer word (2)
[9]

QUESTION 10 / *VRAAG 10*

10.1.1 Nitrogen / N_2 ✓ (1)

10.1.2 N_2 + $3H_2$ ✓ ⇌ $2NH_3$ ✓ (bal ✓) (3)

10.1.3 Ammonia/*Ammoniak* ✓ (1)

10.1.4 Ostwald process ✓ (1)

10.1.5 Ammonium nitrate / NH_4NO_3 ✓ (1)

10.1.6 Eutrophication ✓/*Eutrifikasie* (1)

10.2.1 **A** ✓, Lower nitrogen prevents too much leaf growth at the expense of fruit growth. ✓/*Minder stikstof sal die oormatige groei van die blare ten koste van die vrugte, voorkom.*
OR
It has a higher phosphorus content to promote seed and fruit development. /*Dit het 'n hoër fosforinhoud wat die ontwikkeling van sade en vrugte bevoordeel.*
OR
It has a higher potassium content for seed and fruit quality./*Dit het 'n hoër kaliuminhoud wat die gehalte van die sade en vrugte verhoog.* (2)

10.2.2 $\frac{1}{9}$ ✓ × 20% = 2,222 % ✓

$\frac{2,222}{100}$ × 50 ✓ = 1,11 kg ✓

OR

$\frac{1}{9}$ ✓ × 50 = 5,5556 Kg ✓

$\frac{20}{100}$ × 5,5556 ✓ = 1,11 kg ✓ (4)

[14]

TOTAL/*TOTAAL:* 150