HILLCREST HIGH SCHOOL

PHYSICAL SCIENCE

GRADE 11

PAPER 2- Chemistry

NOVEMBER 2024 MEMO

TIME: 2.5 HRS

Total 125

Section A

Question 1

1.1 C

1.2 D

1.3 A

1.4 D

1.5 B

1.6 A

[12]

Question 2

2.1.1

Empirical formula is the simplest whole number ratio between the elements in a compound.✓✓
Empiriese formule is die eenvoudigste heelgetalverhouding tussen die elemente in 'n verbinding✓✓ (2)

2.1.2

✓ ÷ by smallest

Element	$\frac{g}{10g}$	$n = \frac{m}{M}$ ✓	Simplest ratio/ *Eenvoudigste verhouding*		
K	2,66	2,66/39 = 0,068✓	1	x2	=2
Cr	3,54	3,54/52 = 0,068✓	1	x2	=2
O	3,81	3,81/16 = 0,238✓	3,5	x2	=7

✓ ✓ ✓

Empirical formula/*Empiriese formule*= $K_2Cr_2O_7$✓

(6)

2.2.1 of hydrochloric acid reacts with of calcium carbonate at STP according to the following balanced equation:

$CaCO_3(s) + 2HC\ell(g) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$

Given:	0,5 g	0,448 dm^3
	n = m/M ✓	n = V/V_0 ✓
	= 0,5 / 100 ✓	= 0,448 / 22,4✓
	= 0,005 mol	= 0,02 mol
Needed:	n = 0,02/2 x1✓	n = 0,005/1x2
	= 0,01 mol	= 0,01mol
	LIMITING ✓	EXCESS

Careful – one of the **gaseous reactants is in excess and you need to add** that to the gaseous product that forms

(6)

2.2.2

Excess HCl:	Produce:
n = 0,02 – 0,01 ✓	n = 0,005/1x1 ✓
= 0,01 mol	= 0,005 mol

Total mol = 0,01 + 0,005 ✓ = 0,015 / 0,02 mol gas ✓ (4)

[18]

Question 3

3.1.1 Ea = 65 – 15 ✓ = 50 kJ.mol^{-1} ✓ (2)

3.1.2 ΔH = 40 – 15✓ = 25 kJ.mol^{-1} ✓ (2)

3.1.3 ENDOTHERMIC✓

Energy of products is greater than energy of reactants / ΔH is positive ✓ (2)

3.2.1

NOTE/LET WEL
Give the mark for per unit time only if in context of reaction rate.
Gee die punt vir per eenheidtyd slegs indien in konteks met reaksietempo.

ANY ONE/ENIGE EEN

- Change in concentration ✓ of products/reactants per (unit) time. ✓
  Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
  Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid) tyd.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
- *Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd.*
- Rate of change in concentration/amount/number of moles/volume/mass.
  Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/massa. ✓✓ **(2 or/of 0)** (2)

3.2.2 Temperature/*Temperatuur* ✓ (1)

3.2.3 a) (Decreasing gradient indicates) rate of reaction is decreasing. ✓
(Afnemende gradiënt dui aan dat) reaksietempo afneem. (1)

b) (Gradient is zero, indicates) reaction rate is zero ✓
(Gradiënt is nul, wat aandui dat) reaksietempo nul is. (1)

3.2.4 Ave rate /*Gem. tempo* $= \frac{\Delta V}{\Delta t}$

$$10 = \frac{\Delta V}{20 - 0} \checkmark$$

$$V(O_2)_{\text{produced/}berei} = 200 \text{ cm}^3$$

$$n(O_2)_{\text{produced/}berei} = \frac{V}{V_m}$$

$$= \frac{200}{24000} \checkmark$$

$$= 0{,}0083 \text{ mol}$$

$$n(H_2O_2) = 2n(O_2) \checkmark$$

$$= (2)(0{,}0083)$$

$$= 0{,}017 \text{ mol}$$

$$c(H_2O_2)_{\text{used/}gebruik} = \frac{n}{V}$$

$$= \frac{0{,}017}{0{,}04} \checkmark$$

$$= 0{,}42 \text{ mol·dm}^{-3} \checkmark$$

(5)

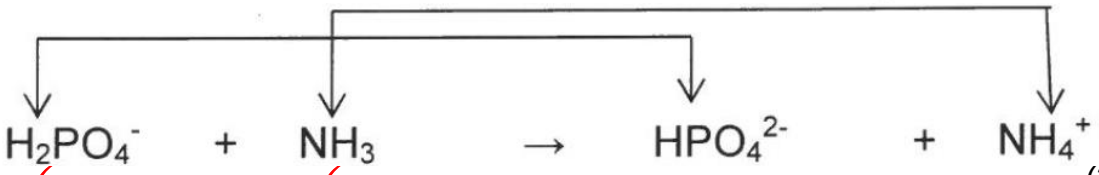
3.2.6 Increasing the temperature would increase the amount of kinetic energy ✓ that the particles have. This would result in more collisions, so more effective collisions per unit time, ✓ INCREASING the rate of the reaction. ✓ (3)

[19]

Question 4

4.1 A base is a proton acceptor ✓ (1)

4.2.1 conjugate pairs/*gekonjugeerde pare*



✓ ✓ (2)

4.2.2 $H_2PO_4^-$ OR/OF HPO_4^{2-} ✓ (1)

4.3 $n = c \times V$; $c_1V_1 = c_2V_2$ ✓ any one

$0,15 \times V_1$ ✓ $= \underline{0,05 \times (150 + V_1)}$ ✓ **(4)**

$V_1 = 75\ cm^3$ ✓

4.4.1 $n(NaOH) = cV$ ✓

$n = \underline{(0,167)(0,300)}$ ✓

$\therefore n(NaOH) = 0,05$ mol ✓ $(5 \times 10^{-2}$ mol) (3)

4.4.2

Marking criteria:	***Nasienkriteria:***
a) Any formula: pH = -log[H_3O^+] / pH = -log[H^+] / pOH = -log[OH^-] / [H_3O^+][OH^-] = 10^{-14} / pH + pOH = 14 ✓ b) Substitute 11,4 in pH = -log[H_3O^+]/ pH + pOH = 14 ✓ c) Substitute calculated [H_3O^+] in [H_3O^+][OH^-] / 2,6 in pOH = -log[OH^-] ✓ d) Final answer: 2,51 x 10^{-3} mol·dm^{-3} ✓ (0,003 mol·dm^{-3})	*a)* Enige formule: pH = - log[H_3O^+] / pH = - log[H^+] / pOH = - log[OH^-] / [H_3O^+][OH^-] = 10^{-14} / pH + pOH = 14 ✓ *b) Vervang* 11,4 in pH = - log[H_3O^+]/ pH + pOH = 14 ✓ *c) Vervang berekende* [H_3O^+] in [H_3O^+][OH^-] / 2,6 in pOH = -log[OH^-] ✓ *d) Finale antwoord:* 2,51x 10^{-3} mol·dm^{-3} ✓ (0,003 mol·dm^{-3})

OPTION 1/*OPSIE 1*

pH = - log[H_3O^+]

11,4 ✓**(b)** = - log[H_3O^+] **OR/*OF*** [H_3O^+] = $10^{-11,4}$ → Any one/*Enige een* ✓**(a)**

[H_3O^+] = 3,98 x 10^{-12}

[H_3O^+][OH^-] = 10^{-14}

✓**(c)**

(3,98 x 10^{-12})[OH^-] = 1 x 10^{-14}

[OH^-] = 2,51 x 10^{-3} mol·dm^{-3} ✓**(d)** (0,003)

OPTION 2/*OPSIE 2*

pH + pOH = 14

11,4 + pOH = 14 ✓**(b)** → Any one/*Enige een* ✓**(a)**

pOH = 2,6

pOH = -log[OH^-] ✓

2,6 ✓**(c)** = -log[OH^-]

[OH^-] = 2,51 x 10^{-3} mol·dm^{-3} ✓**(d)** (0,003)

(4)

4.4.3

POSITIVE MARKING FROM QUESTION 7.2.1. AND 7.2.2.
POSITIEWE NASIEN VANAF VRAAG 7.2.1. EN 7.2.2.

Marking criteria:

a) Substitute [NaOH] = 0,00251 mol·dm^{-3} (answer from Q7.2.2) and 0,8 in $c = \frac{n}{V}$ ✓

b) Subtract: $n(NaOH)_{initial}$ (from Q7.2.1) – $n(NaOH)_{mixture}$ ✓✓

c) Use of ratio: $n(OH^-) = n(CH_3COOH)$ ✓

d) Substitute 0,5 and $\Delta n(CH_3COOH)$[calculated by subtraction] into $c = \frac{n}{V}$ ✓

e) Final correct answer: 0,096 mol·dm^{-3} ✓
Range: 0,095 to 0,1 mol·dm^{-3}

Nasienkriteria:

a) *Vervang [NaOH] = 0,00251 mol·dm^{-3} (antwoord van Q7.2.2) en 0,8 in* $c = \frac{n}{V}$ ✓

b) *Trek af: $n(NaOH)_{aanvanklik}$ (vanaf Q7.2.1) – $n(NaOH)_{mengsel}$* ✓✓

c) *Gebruik verhouding: $n(OH^-) = n(CH_3COOH)$* ✓

d) *Vervang 0,5 en $\Delta n(CH_3COOH)$ [bereken deur aftrekking] in* $c = \frac{n}{V}$ ✓

e) *Finale korrekte antwoord: 0,096 mol·dm^{-3}* ✓
Gebied: 0,095 tot 0,1 mol·dm^{-3}

$n(NaOH)_{mixture} = cV$
$= 0,00251 \times 0,8$ ✓**(a)**
$= 0,002$ mol (0,0024)

$n(NaOH)_{reacted} = 0,05 - 0,002$ ✓✓**(b)**
$= 0,048$ mol (0,0476)

$n(NaOH)_{reacted} = n(CH_3COOH)_{used}$
$= 0,048$ mol ✓**(c)**

$[CH_3COOH] = \frac{n}{V}$
$= \frac{0,048}{0,5}$ ✓**(d)**
$= 0,096$ mol·dm^{-3} ✓**(e)**
(0,0952)

NOTE/*LET WEL*
IF/*INDIEN:*

- $\frac{c_a V_a}{c_b V_b} = \frac{1}{1}$ Max./*Maks.* $^1/_6$
- Answer from Q7.2.1 substituted in $c = \frac{n}{V}$ to obtain an answer of 0,01 mol·dm^{-3}./
  Antwoord van Q7.2.1 vervang in $c = \frac{n}{V}$ *om 0,01 mol·dm^{-3} as antwoord te kry.*
  Max./*Maks.* $^1/_6$

(6)

[21]

Or

4.4.2) ① $pH = -\log [H_3O^+]$ ✓Formula

$11,4 = -\log [H_3O^+]$ ✓sub

$[H_3O^+] = 3,9811 \times 10^{-12}$

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

$[OH^-][3,9811 \times 10^{-12}] = 1 \times 10^{-14}$ ✓A

$[OH^-] = 2,51 \times 10^{-3}$ mol.dm^{-3}

① $pH + pOH = 14$ ✓Formula

$11,4 + pOH = 14$ ✓sub

$pOH = 2,6$

(4)

$pOH = -\log [OH^-]$ ✓sub

$2,6 = -\log [OH^-]$ ✓A

$[OH^-] = 2,51 \times 10^{-3}$ mol.dm^{-3}

4.4.3) Excess

$NaOH + CH_3COOH \rightarrow$

excess $[OH^-] = 2,51 \times 10^{-3}$ mol.dm^{-3}

$n_{OH^-(excess)} = C.V_T$ ✓CA sub

$= 2,51 \times 10^{-3} (0,8)$

$= 2,008 \times 10^{-3}$ mol

Reacted = Given - excess

$= 0,05 - 2,008 \times 10^{-3}$ ✓m

$= 4,7992 \times 10^{-2}$ mol.

$n_{OH^-} = n_{NaOH}$ ✓

$4,7992 \times 10^{-2}$ mol ÷ 1 × 1 ✓If reacted used m

$= 4,7992 \times 10^{-2}$ mol

(6)

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

$= \frac{4,7992 \times 10^{-2}}{0,5}$ ✓sub

$= 9,6 \times 10^{-2}$ mol.dm^{-3} / 0,1 mol.dm^{-3} ✓CA from 4.4.2

Question 5

5.1 Electronegativity is a measure of the tendency of an atom in a molecule to attract bonding electrons. ✓✓
Elektronegatiwiteit is 'n maatstaf van die neiging van 'n atoom in 'n molekuul om bindingselektrone aan te trek✓✓ (2)

5.2  ✓✓

Marking Criteria/*Nasienkriteria*
- All atoms shown with 8 electrons around it.
  Alle atome met 8 elektrone rondom elk getoon
- Two electron pairs on O atoms shared with two F atoms as shown.
  Twee elektronpare op O-atome gedeel met twee F-atome, soos getoon

NOTE: Accept bent/angular Lewis structure
NOTA: *Aanvaar hoekige struktuur* (2)

5.3

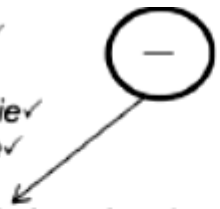
The bonds in both molecules are polar due to the electronegativity difference between O and F and then C and O

OF_2 is bent

CO_2 is linear

OF_2 has asymmetrical distribution of charge and CO_2 has symmetrical distribution of charge.

5.4.1 X = bond energy ✓
Y = bond length ✓
X = bindingsenergie✓
Y = bindingslengte✓ (2)



5.4.2 The energy needed to break one mole of its molecules into separate atoms.✓✓
Die energie benodig om een mol van sy molekules in aparte atome op te breek.✓✓ (2)

[12]

Question 6

6.1.1 pentane / heptane ✓ (1)

6.1.2 propane ✓ (1)

6.2.1 Van der Waal's London forces✓ (1)

6.2.2 As molecular size increases, boiling point increases. ✓ (1)

6.2.2 As molecular size increases, vdW London forces increase in strength. ✓ Thus bigger molecules require more energy to separate the molecules and thus BP is higher. ✓ (2)

[6]

Question 7

7.1 Volume is inversely proportional ✓to pressure. ✓ (2)

7.2 Temperature / no of moles of gas ✓

Careful – the graph shows $\frac{1}{V}$ **and you need to invert this at the end**

7.3 $P_1 = 100$ kPa ; $\frac{1}{V_1} = x$ dm^{-3}

$P_2 = 120$ kPa ; $\frac{1}{V_2} = 3,5$ dm^{-3} $\therefore V_2 = \frac{1}{3,5} = 0,29\ dm^3$

$P_1V_1 = P_2V_2$ ✓

100 ✓ x V_1 = 120 ✓ x 0,29 ✓

$\therefore V_1 = 0,35$ dm^3 ✓

$x = \frac{1}{V_1} = \frac{1}{0,35} = 2,86$ dm^{-3} ✓ (6)

7.4 Boyles Law (1)

[10]

Question 8

8.1 Increase in oxidation number (1)

8.2.1 Copper (1)

8.2.2 Ag^+ (1)

8.2.3 $Ag^+(aq) + 2e \rightarrow Ag(s)$ (2)

[5]

Question 9

9.1 Temperature of 25 ºC/298K✓
Pressure 101,3 kPa✓
Concentration of electrolyte of 1mol.dm^{-3}✓ (3)

9.2 Chlorine (molecule)✓ ✓ (1)

9.3

OPTION 1

$E^{\ominus}_{cell} = E^{\ominus}_{cathode} - E^{\ominus}_{anode}$ ✓
$= 1,36$ ✓ $- (-1,66)$ ✓
$= 3,02$ V ✓

Notes
- Accept any other correct formula from the data sheet.
- Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:
  $E°_{sel} = E°_{OM} - E°_{RM}$ *Max/:* $^{3}/_{4}$

OPTION 2

✓	$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$	1,36 (V) ✓
	$Al(s) \rightarrow Al^{3+}(aq) + 3e^-$	-1,66 (V) ✓
	$Al(s) + Cl_2(g) \rightarrow Al^{3+}(aq) + 2Cl^-(aq)$	3,02 (V) ✓

(4)

9.4

Al(s)/Al $^{3+}$(aq)(1 mol.dm^{-3}) ✓ //✓ Pt(s)/Cl_2(g)(1atm)/Cl^-(aq)(1 mol.dm^{-3}) ✓

Or

Al(s)/Al $^{3+}$(aq)(1 mol.dm^{-3}) ✓ //✓ Cl_2(g)(1atm)/Cl^-(aq)(1 mol.dm^{-3})/Pt(s) ✓

[11]

Question 10

10.1 A substance of which the aqueous solution contains ions OR
A substance that dissolves in water to give a solution that conducts electricity. (2)

10.2 B ✓ (1)

10.3 $Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$ ✓✓ (2)

10.4 (2)

n (e) in 1 hour = $7,22 \times 10^{22}$ x60x60 ✓ = $2,6 \times 10^{26}$

n (e) = N_0/N_A ✓

= $2,6 \times 10^{26}$ / $6,02 \times 10^{23}$ ✓

= 4,32 mol

n (Cu) = 4,32 ÷ 2 ✓

= 2,16 mol

m (Cu) = n x M

= 2,16 x 63,5 ✓**m**

= 137,13 g ✓

(6)

[11]

Total 125