Physical Science HG Paper 2

Natuur-en Skeikunde HG Vraestel 2

QUESTION 1 / *VRAAG 1*

1.1	D	1.2	B	1.3	C	1.4	A	1.5	B
1.6	B	1.7	D	1.8	B	1.9	D	1.10	D
1.11	D	1.12	C	1.13	C	1.14	A	1.15	B

4 X 15 =[60]

QUESTION 2 / *VRAAG 2*

2.1

2.1.1 $p \alpha \frac{1}{V}$ ✓✓ **OR/*OF*** $pV = k$ ✓✓ (2)

pV = 989 J

If $p_1V_1 = p_2V_2$ then only ✔ (1/2)
As $p_1V_1 = p_2V_2$ dan slegs (1/2)
pV = nRT (0/2)

Any mathematical manipulation of correct relationship
Enige wiskundige manipulasie van korrekte verwantskap

NOT/NIE $p = \frac{1}{V}$

2.1.2 $[pV] = \frac{N}{m^2} \times \frac{m^3}{1} = Nm = J$ (2)

$[pV = nRT] = mol.J.K^{-1}.mol^{-1}K = J$

$[pV = \frac{F}{A} \times V = F \times s = w] == J$

2.1.3 Helium *OR/OF* He ✓ (1)

2.1.4 $pV = nRT$ ✓

$989 = 0,4 \times 8,31 \times T$

$\therefore T = 297,5$ K OR/OF 298 K (4)

$pV = nRT$
$\therefore T = \frac{pV}{nR} = \frac{989}{0,4 \times 8,31}$
$= 297,5$ K OR/OF 298 K

If R = 8,3 had been used: -1
Indien R = 8,3 gebruik is: -1

If pV = nRt: No mark for formula, but mark rest of question
Indien pV = nRt: Geen punte vir formule, maar merk res

2.1.5 IMF causes volume (or p or pV) of gas to be lower than expected according to pV = nRT (2)
IMK veroorsaak 'n laer gasvolume (of p of pV) as wat verwag word volgens pV = nRT.

2.1.6 The volume of the molecules (particles) become significant (or contributes to the volume of the gas), hence a larger p or V or pV (2)
By hoë druk speel die volume van die molekule (partikels/deeltjies) 'n rol (of dra by tot die gasvolume), gevolglik 'n hoër p of V of pV.
NOT repulsive forces / **NIE** afstotende kragte nie

2.1.7 $n(B) > n(A)$ OR/*OF* $n(B) \neq n(A)$ OR/*OF* number of molecules of A ≠ number of molecules of B / aantal molekule van A ≠ aantal molekule van B (2)

OR/*OF* The number of mole of B is larger than the number of mole of A
Die aantal mol B is groter dan die aantal mol A

OR/*OF* Substance quantity of B > than substance quantity of A
Stofhoeveelheid van B > Stofhoeveelheid van A

2.2

2.2.1 $c[Ca(NO_3)_2] = \frac{m}{MV}$

$= \frac{10}{164 \times 0,5}$

$= 0,12 \text{ mol.dm}^{-3}$

$\therefore c[NO_3^-] = 2 \times 0,12$

$= 0,24 \text{ mol.dm}^{-3}$ ✓

OR/ *OF*

$m(NO_3^-) = \frac{2 \times 62}{164} \times 10 = \frac{124}{164} = 7,56 \text{ g}$

$c[NO_3^-] = \frac{m}{MV} = \frac{7,56}{62 \times 0,5}$

$= 0,24 \text{ mol.dm}^{-3}$ ✓

OR/ *OF*

$c[NO_3] = 2 \times c[Ca(NO_3)_2]$

$= 2 \times \frac{m}{MV} = 2 \times \frac{10}{164 \times 0,5}$

$= 0,24 \text{ mol.dm}^{-3}$

OR ***OF***

$M_r(Ca(NO_3)_2) = 164 \text{ g.mol}^{-1}$

$n = \frac{m}{M_r} = \frac{10}{164} = 0,06 \text{ mol}$

$\therefore n(NO_3^-) = 2 \times n(Ca(NO_3)_2) = 0,12 \text{ mol}$

$\therefore [NO_3^-] = \frac{n}{V} = \frac{0,12}{0,5} = 0,24 \text{ mol.dm}^{-3}$

1 mark for both 10 g and 0,5 dm^3
1 punt vir beide 10 g en 0,5 dm^3

$m(NO_3^-) = \frac{2 \times 62}{164} \times 10 = \frac{124}{164} = 7,56 \text{ g}$

$n = \frac{m}{M_r} = \frac{7,56}{62} = 0,12 \text{ mol}$

$c[NO_3^-] = \frac{n}{V} = \frac{0,12}{0,5} = 0,24 \text{ mol.dm}^{-3}$

1 mark for both 7,56 g and 0,5 dm^3
1 punt vir beide 7,56 g en 0,5 dm^3

(4)

2.2.2 Xylene is a non-polar solvent and $Ca(NO_3)_2$ is an ionic solute

Xileen is 'n nie-polêre oplosmiddel en $Ca(NO_3)_2$ is 'n ioniese stof

∴ Intermolecular forces are not of comparable strength. ✔

∴ *Die sterkte van die intermolekulêre kragte is nie van dieselfde orde nie.* (3)

OR/OF

Xylene has Van der Waals forces ✔ and $Ca(NO_3)_2$ ionic bonding. ✔
Xileen het Van der Waalskragte en $Ca(NO_3)_2$ ioniese binding

∴ Intermolecular forces are not of comparable strength.
∴ *Die sterkte van die intermolekulêre kragte is nie van dieselfde orde nie.*

OR/OF

Xylene has weak IMF ✔ and $Ca(NO_3)_2$ strong IMF. ✔
Xileen het swak IMK en $Ca(NO_3)_2$ sterk IMF

∴ Intermolecular forces are not of comparable strength. ✔
∴ *Die sterkte van die intermolekulêre kragte is nie van dieselfde orde nie.*

OR/OF

If only: Intermolecular forces are not comparable in strength: $\frac{1}{3}$

As slegs: Intermolekulêre kragte is nie vergelykbaar in sterkte: $\frac{1}{3}$

[22]

QUESTION 3 / *VRAAG 3*

3.1

3.1.1 Sulphur dioxide/ *Swaweldioksied* (SO_2) (2)

Sulphur (IV) oxide/ *Swawel(IV)oksied*

3.1.2 sulphurous acid/*swaweligsuur* (H_2SO_3) (2)

OR/*OF* hydrogen sulphite / *waterstofsulfiet*

3.1.3 $2SO_2 + O_2 \rightarrow 2SO_3$ (✔bal) (Accept/*Aanvaar* ⇌) (2)

3.1.4 H_2SO_4 (Sulphuric acid/ *swawelsuur*) (2)

3.2 $2H_2S + SO_2 \rightarrow 3S + 2H_2O$ (✔ **bal**) ⇌ -1 (3)

$2CaS + SO_2 \rightarrow 3S + 2CaO$ or other sulphide/of ander sulfied

[11]

QUESTION 4 / *VRAAG 4*

4.1.1 $2NH_4C\ell + Ca(OH)_2 \rightarrow CaC\ell_2 + 2NH_3 + 2H_2O$ (✓ balancing) (4)

Or other hydroxide/Of ander hidroksied

⇌ -1

4.1.2 Water (H_2O)✓✓ (2)

4.1.3 Moist red litmus (or universal paper) held at the mouth of the test tube turns blue/basic. (2)

Marks for: Moist litmus (universal) turns blue/colour change

'n Klam rooi lakmoes- (of universele-)papiertjie wat by die bek van die proefbuis gehou word sal blou (basies) verkleur

Punte vir: Klam lakmoes (universele) word blou/kleurverandering

4.1.4 Less dense than air./ *Minder dig as lug*. (Accept lighter/*Aanvaar ligter*) (2)

Comparison between air and ammonia has to be made
Vergelyking tussen lug en ammoniakmoet gemaak word.

4.2.1 INCREASES/ *NEEM TOE* ✓✓ (2)

4.2.2 $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ (✓ bal) ✓ Single arrows accepted
Enkelpyle aanvaar

Accept/Aanvaar: $NH_3 + H_2O \rightleftharpoons NH_4OH$

4.2.3 Solution becomes colourless. / *Oplossing word kleurloos* (1)
OR/*OF* Becomes lighter pink / *Kleur ligter pienk*
OR/*OF* pH of solution decreases/ *pH van oplossing daal*

4.2.4 $[NH_4^+]$ is increased. ✓

If stated that NH_3 forms in 4.2.3, then mark mark 4.2.4 positive
Indien gesê dat NH_3 vorm in 4.2.3, merk 4.2.4 dan positief.

According to Le Chatelier's Principle, the system will tend to oppose this increase by favouring the reverse reaction. ✓ Less OH^- form/ $[OH^-]$ decreases. (3)

$[NH_4^+]$ neem toe.

Na aanleiding van Le Chatelier se beginsel, sal die sisteem die verhoging in konsentrasie teenwerk deur die terugwaartse reaksie te bevoordeel.

Minder OH^- vorm/$[OH^-]$ verlaag.

[19]

QUESTION 5 / *VRAAG 5*

5.1 KI ✓✓ (potassium iodide ✓/ *Kaliumjodied)* (2)

5.2 $2KI \overset{\checkmark}{+} Cl_2 \rightarrow 2KCl \overset{\checkmark}{+} I_2$ (✓ balancing/ *balansering*) -1 (3)

OR/OF $2I^- + Cl_2 \rightarrow 2Cl^- + I_2$

(If 5.1: KBr : mark 5.2 positive */As 5.1: KBr : merk 5.2 positief)*
$2KBr + Cl_2 \rightarrow 2KCl + Br_2$

[5]

QUESTION 6/ *VRAAG 6*

6.1

6.1.1 Gas (CO_2) is escaping from the beaker. ✓✓ 2 or/of 0 (2)
Gas (CO_2) ontsnap uit die beker

6.1.2 Reaction is complete (stopped)/No more gas escapes./Reactants used up ✓✓ (2)
Reaksie is voltooi /Geen gas word meer vrygestel nie/Reaktanse opgebruik
(Reaction in equilibrium – NO MARKS / Reaksie in ewewig – GEEN PUNTE)

6.1.3(a) B ✓✓ (2)

6.1.3(b) A ✓✓ (2)

6.1.3(c) C ✓✓ (2)

6.2.1 Low concentration of NO./ *Lae konsentrasie NO* ✓✓ (2)
OR/*OF* Small amount of NO/ *Klein hoeveelheid NO*
OR/*OF* Low yield of NO/ *Lae opbrengs NO*

6.2.2

	N_2	O_2	NO
Moles initial/ *Mol aanvanklik*	7	2	0
Moles formed/ *Mol gevorm*			0,4
Moles reacted/ *Mol gereageer*	0,2	0,2	
Moles at Equil./*Mol by ewewig*	6,8 ✓	1,8 ✓	0,4
Conc. at Equil./*Kons by ewewig*	3,4	0,9	0,2 ✓

$$K_c = \frac{[NO]^2}{[N_2][O_2]} \overset{\checkmark}{=} \frac{(0,2)^2}{(3,4)(0,9)} \overset{\checkmark}{=} 1,3\times10^{-2} = 0,013$$

Accept $K_C = 0,01$
Aanvaart $K_C = 0,01$

If K_C has a unit: -1
As K_C 'n eenheid het: -1

(8)

Principles:

Only the correct answer gets the final mark
Mark positive from table/calculations of n and c to K_C calculation
If n values substituted in K_C instead of c, mark positive (max $^6/_8$) (Although answer may be correct)

If table was used and K_C calculated, OR calculations of n,c and K_C shown without table

1 correct concentrations calculated and calculation shown ($^8/_8$)
2 one of $n(N_2)$ or $n(O_2)$ incorrect, but c and K_C calculations correct $^6/_8$
3 both $n(N_2)$ and $n(O_2)$ incorrect, but c and K_C calculations correct $^5/_8$
4 one of $n(N_2)$ or $n(O_2)$ incorrect and c not calculated or incorrect, but K_C calculations correct (using n or wrong c values) $^5/_8$
5 both $n(N_2)$ and $n(O_2)$ incorrect and c not calculated or incorrect, but K_C calculations correct (using n or wrong c values) $^4/_8$

If table was NOT used, or or calculations of n and c not shown

6 correct concentrations substituted in K_C but calculations of c not shown $^5/_8$
7 wrong c values substituted in K_C $^1/_8$

Beginsels

Slegs die korrekte antwoord kry laaste punt
Merk positief van tabel/berekening van n en c na K_C-berekenig
Indien n-waardes ipv c in K_C gesubstitueer is, merk positief (maks $^6/_8$) (*Al mag antwoord korrek wees)*

As tabel gebruik en is maar

1. korrekte konsentrasies bereken en berekening aangetoon (maks $^8/_8$)
2 een van $n(N_2)$ of $n(O_2)$ verkeerd, maar c- en K_C–berekenings korrek $^6/_8$
3 beide $n(N_2)$ en $n(O_2)$ verkeerd, maar c- en K_C–berekenings korrek $^5/_8$
4 een van $n(N_2)$ of $n(O_2)$ verkeerd en c nie bereken of verkeerd, maar K_C–berekenings korrek (deur gebruik van n- of verkeerde c-waardes) $^5/_8$
5 beide $n(N_2)$ en $n(O_2)$ verkeerd en c nie bereken of verkeerd, maar K_C–berekenings korrek (deur gebruik van n- of verkeerde c-waardes) $^4/_8$

Indien tabel NIE gebruik is nie, of berekenings van n en c nie getoon is nie

6 korrekte konsentrasies in K_C gesubsttitueer maar berekening van nie aangetoon nie $^5/_8$
7 verkeerde c-waardes in K_C gesubstitueer $^1/_8$

6.2.3 Increase in K_c and/or [NO] was increased, thus the forward reaction was favoured.
If the temperature is increased, the system will tend to decrease T (LCP), favouring the endothermic reaction ✓✓ (4)

'n Toename in K_c en/of die [NO] toegeneem het, en dat die voorwaartse reaksie bevoordeel was.
As die temperatuur verhoog word, sal die sisteem neig om die T te verlaag (LCB), wat die endotermiese reaksie bevoordeel **[24]**

QUESTION 7/ *VRAAG 7*

7.1 Acid ionises/dissociates (almost) completely in water ✓✓ (2)
'n Suur wat byna (volledig) ioniseer/dissosieer in water.

OR Has a large K_a value
OF Het 'n hoë K_a waarde.

7.2 $CO_3^{2-}(aq) + H_2O(\ell) \rightleftharpoons HCO_3^-(aq) + OH^-(aq)$ (Accept/*Aanvaar* →) (3)

OR/OF $Na_2CO_3 + 2H_2O \rightleftharpoons NaHCO_3 + NaOH$

OR/OF $CO_3^{2-}(aq) + 2H_2O(\ell) \rightleftharpoons H_2CO_3(aq) + 2OH^-(aq)$

OR/OF $Na_2CO_3 + 2H_2O \rightleftharpoons H_2CO_3 + 2NaOH$

OR/OF

$Na_2CO_3 \xrightarrow{H_2O} Na^+ + CO_3^{2-}$

$CO_3^{2-} + 2H_2O \rightarrow HCO_3^- + OH^-$

7.3.1 $pH = -\log[H^+]$ ✓ (Answer only /*Antwoord alleen* $^2/_2$)

$\therefore 3 = -\log[H^+]$

$\therefore [H^+] = 10^{-3}\ mol.dm^{-3}$ ✓ (2)

7.3.2 No/ *Nee* ✓ − (1)

7.3.3 Since $[H^+] < 0{,}01\ mol.dm^{-3}$ the acid does not ionise completely. (2)
Aangesien $[H^+] < 0{,}01\ mol.dm^{-3}$ het die suur nie volledig geioniseer nie.

pH of/van 0,01 $mol.dm^{-3}$ HCℓ = 2 andpH of/van 0,01 $mol.dm^{-3}$ X = 3
$\therefore$pH(HCℓ) < pH(X) **for the same concentration/vir dieselfde konsentrasie**

7.4

$n(NaOH) = c \times V = 0{,}5 \times 0{,}028 = 0{,}014\ mol$

$n(HCℓ)_{excess/oormaat} = n(NaOH) = 0{,}014\ mol$

$n(HCℓ)_{TOT} = c \times V = 1 \times 50 \times 10^{-3} = 0{,}05\ mol$

n(HCℓ) reacting with/ *reageer met* $CaCO_3$ = 0,05 - 0,014 = **0,036 mol**

$\therefore n(CaCO_3) = ½ \times$ **0,036** = 0,018 mol

$\therefore m(CaCO_3) = n \times M = 0{,}018 \times 100 = 1{,}8\ g$ (10)

$n(NaOH) = c \times V = 0{,}5 \times 0{,}028 = 0{,}014\ mol$

$n(HCℓ)_{excess/oormaat} = n(NaOH) = 0{,}014\ mol$

$V(HCℓ) = \frac{n}{c} = \frac{0{,}014}{1} = 0{,}014\ dm^3$

$\therefore V(HCℓ)$ reacting with $CaCO_3$ = 50 – 14 = 36 cm^3
∴ V(HCℓ) reageer met $CaCO_3$

$\therefore n(HCℓ)$ reacting with $CaCO_3 = c \times V$
∴ n(HCℓ) reageer met $CaCO_3$

$= 1 \times 36 \times 10^{-3}\ mol$

$=$ **0,036 mol**

$\therefore n(CaCO_3) = ½ \times$ **0,036** = 0,018mol

$\therefore m(CaCO_3) = n \times M = 0{,}018 \times 100 = 1{,}8\ g$

$\frac{n_a}{n_b} = \frac{v_a x c_a}{v_b x c_b}$

$\therefore V_a = \frac{0{,}5 \times 28 \times 1}{1 \times 1} = 14\ cm^3$

$\therefore V(HCℓ)$ reacting with $CaCO_3$ = 50 – 14 = 36 cm^3
∴ V(HCℓ) reageer met $CaCO_3$

$\therefore n(HCℓ)$ reacting with $CaCO_3 = c \times V$
∴ n(HCℓ) reageer met $CaCO_3$

$= 1 \times 36 \times 10^{-3}\ mol$

$=$ **0,036 mol**

$\therefore n(CaCO_3) = ½ \times$ **0,036** = 0,018mol

$\therefore m(CaCO_3) = n \times M = 0{,}018 \times 100 = 1{,}8\ g$

[20]

QUESTION 8/ *VRAAG 8*

8.1.1 $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ ✓✓ (2)

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	(½)
$Cr_2O_7^{2-} + 14H^+ + 6e^- \leftarrow 2Cr^{3+} + 7H_2O$	(0/2)
$2Cr^{3+} + 7H_2O \leftarrow Cr_2O_7^{2-} + 14H^+ + 6e^-$	(2/2)
$2Cr^{3+} + 7H_2O \rightleftharpoons Cr_2O_7^{2-} + 14H^+ + 6e^-$	(0/2)

8.1.2 (With an E° = +1,33 V) potassium dichromate is a stronger oxidising agent than CO_2 and can therefore oxidise $H_2C_2O_4$ (oxalic acid). ✓✓ ✓✓
(Met 'n E° = +1,33 V) is kaliumdichromaat 'n sterker oksideermiddel as CO_2 en oksideer $H_2C_2O_4$ (oksaalsuur) **OR/ OF**

$E°_{cell} = E°_{red} - E°_{ox}$ $= 1,33 - (-0,49)$ $= 1,82$ V Since E° is positive, reaction is spontaneous. ✓✓ *Aangesien E° positief is, is reaksie spontaan*	$H_2C_2O_4$ (oxalic acid) is a stronger reducing agent than Cr^{3+} and ✓✓ can therefore reduce $Cr_2O_7^{2-}$ to Cr^{3+}. ✓✓ *$H_2C_2O_4$ (oksaalsuur) is 'n sterker reduseermiddel dan Cr^{3+} en kan daarom $Cr_2O_7^{2-}$ reduseer na Cr^{3+}.*	OR $Cr_2O_7^{2-}$ is a strong enough OA to oxidise $H_2C_2O_4$ ✓✓ OF $Cr_2O_7^{2-}$ is 'n sterk genoeg OM om $H_2C_2O_4$ te osideer ✓✓

(4)

8.1.3 $H_2C_2O_4 \rightarrow 2CO_2 + 2H^+ + 2e^-$ ✓✓
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ ✓
$Cr_2O_7^{2-} + 3\,H_2C_2O_4$ ✓ $+ 8H^+ \rightarrow 2Cr^{3+} + 6CO_2 + 7H_2O$ ✓

No alternative accepted *Geen ander moontlikhede*	The reduction half reaction may be written first *Die reduksie-halfreaksies kan eerste geskryf word*

If ⇌ - 1 (once for 8.1.3)/(eenmaal vir 8.1.3)
Charges omitted/*Ladings uitgelaat* - 1
per halfreaction/equation per halfreaksie/vgl

(5)

8.2
8.2.1 Pt ✓ **OR/OF** Pt, O_2 / H_2O_2 (1)

8.2.2 $Cu \rightarrow Cu^{2+} + 2e^-$ ✓✓ (2)

$Cu \rightleftharpoons Cu^{2+} + 2e^-$	(½)
$Cu \leftarrow Cu^{2+} + 2e^-$	(0/2)
$Cu^{2+} + 2e^- \leftarrow Cu$	(2/2)
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	(0/2)

8.2.3 $O_2 + 2H^+ + 2e^- \rightarrow H_2O_2$ ✓✓ (2)

If 8.2.2 and 8.2.3 are swopped around : 2/4
As 8.2.2 en 8.2.3 omgeruil word : 2/4

$O_2 + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	(½)
$O_2 + 2H^+ + 2e^- \leftarrow H_2O_2$	(0/2)
$H_2O_2 \leftarrow O_2 + 2H^+ + 2e^-$	(2/2)
$H_2O_2 \rightleftharpoons O_2 + 2H^+ + 2e^-$	(0/2)

8.2.4 $E°_{cell/sel} = E°_{OA/OM} - E°_{RA/RM}$ ✓ $(= E°_{cat/kat} - E°_{anode})$
$= 0,68$ ✓ $- 0,34$ ✓
$= 0,34$ V ✓

The formula $E°_{red} - E°_{ox/oks}$ is accepted provided that the substitution is correct
Die formule $E°_{red} - E°_{ox/oks}$ word aanvaar op voorwaarde dat die substitusie reg is

(4)

8.2.5 K^+ ✓✓ (2)
[22]

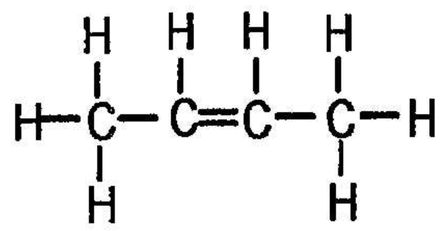
QUESTION 9/ *VRAAG 9*

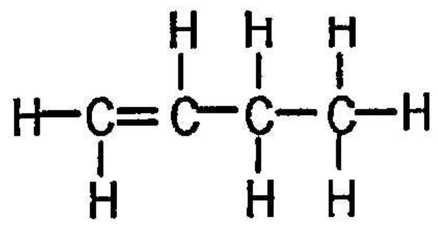
9.1

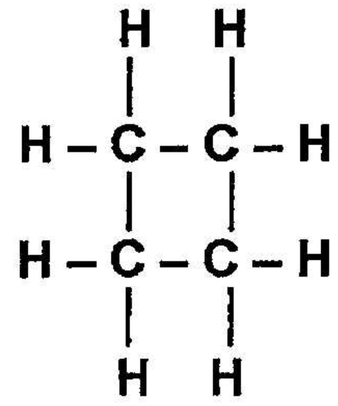
9.1.1 methylpropene/ *metielpropeen* ✓✓ (2)

Accept/*Aanvaar*
2-methylprop-1-ene /*2-metielprop-1-een*
2-methylpropene /*2-metielpropeen*

9.1.2 ✓✓ ✓✓ ✓✓







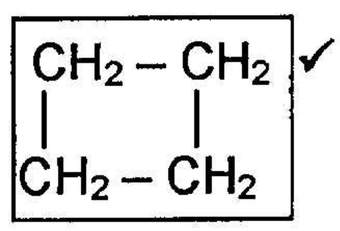
Any two accepted /*Enige twee moontlikhede word aanvaar*

If Hydrogens are omitted: ½ *As Waterstof uitgelaat word:* ½

(4)

If condensed structures were used:
Indien gekondenseerde strukture gebruik is:

$CH_3CH{=}CHCH_3$ ✓ $CH_2{=}CH\ CH_2CH_3$ ✓


✓

9.2 $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$ (✓ balancing/ *balansering*) (3)

9.3

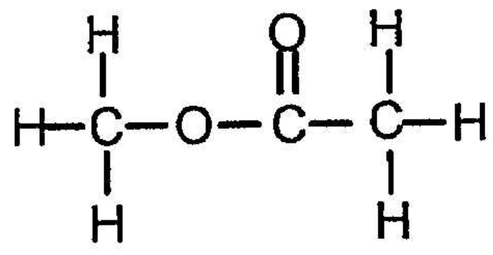
9.3.1 Ethanol/ *Etanol* ✓✓ (CH_3CH_2OH) (2)

OR/*OF* Ethanal/ *Etanal* (CH_3CHO)

9.3.2 Water ✓✓ **OR/*OF*** (di)hydrogenoxide / *(di)waterstofoksied* (2)

(H_2O) ✓

9.3.3 Methyl ethanoate/ *Metieletanoaat* ✓✓



✓✓

If Hydrogens are omitted: ½
As Waterstof uitgelaat word: ½

(4)
[17]

200 marks/ *punte*