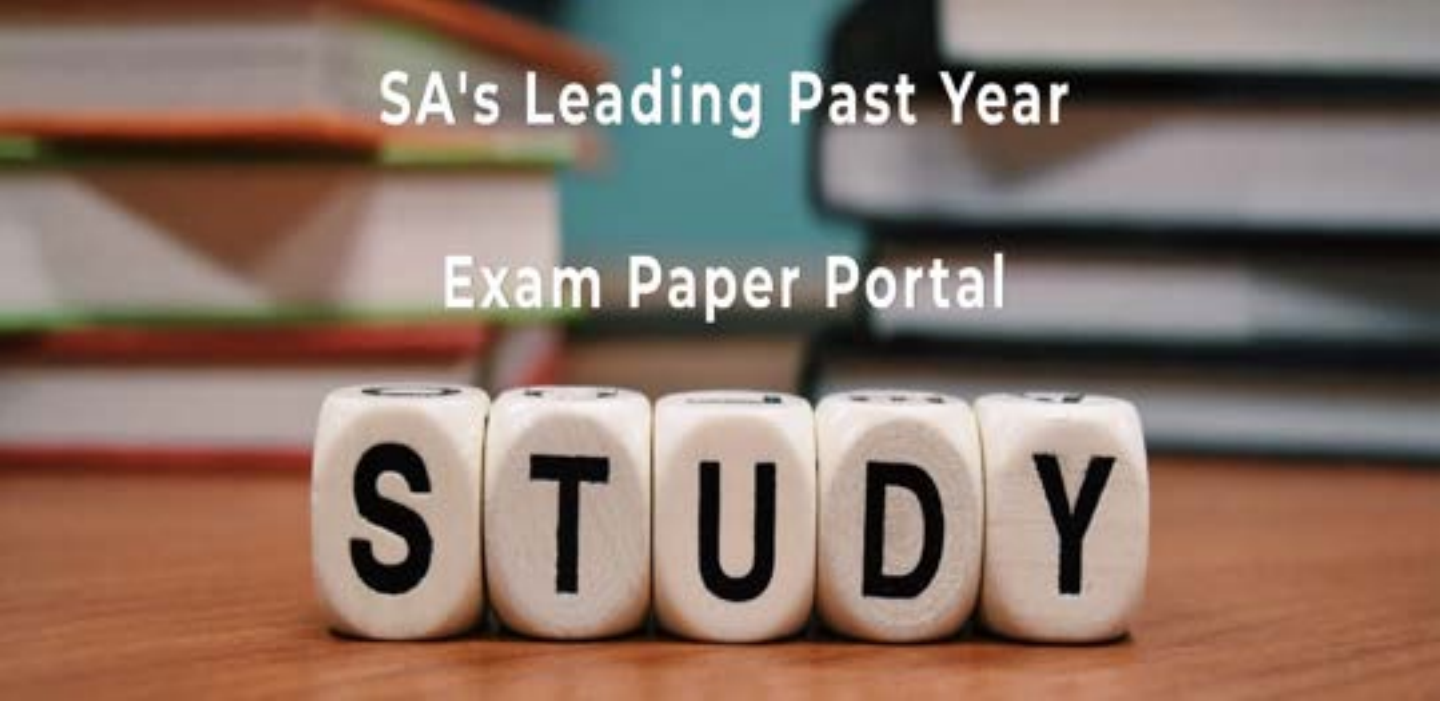


education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS P2

SEPTEMBER 2020

MARKING GUIDELINE

MARKS/PUNTE: 150

This memorandum consists of 13 pages

Hierdie memorandum bestaan uit 13 bladsye

QUESTION 1 / VRAAG 1

1.1 B✓✓

1.2 C✓✓

1.3 A✓✓

1.4 A✓✓

1.5 D✓✓

1.6 B✓✓

1.7 D✓✓

1.8 C✓✓

1.9 D✓✓

1.10 B ✓✓

[20]

QUESTION 2 / VRAAG 2

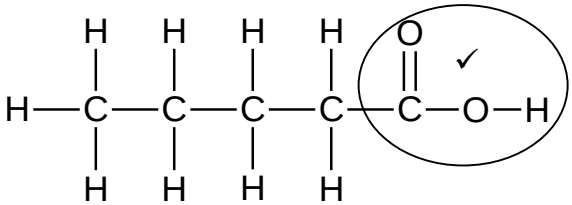
2.1.1 A bond or an atom or a group of atoms ✓that determine(s) the physical and chemical properties of a group of ✓organic compounds.
'n Binding of 'n atoom of 'n groep atome wat die fisiese en chemiese eienskappe van 'n groep organiese verbindings bepaal. (2)

2.1.2 Formyl group/*Formielgroep*✓ (1)

2.1.3 $C_nH_{2n}O$✓ (1)

2.2.1 Same molecular formula, ✓ but different functional groups. ✓
Dieselfde molekulêre formule, maar verskillende funksionele groepe (2)

2.2.2



✓

Marking criteria / *Nasienriglyne*

- Functional group correct / *Funksionele groep korrek*✓
- Whole structure correct / *Hele struktuur korrek* ✓

(2)

2.2.3 Esterification / *Esterifikasie*✓Accept/*Anvaar:*Condensation/*kondensasie* (1)

2.2.4 Ethanol / *Etanol*✓ (1)

2.2.5 (Concentrated) Sulphuric acid /*(Gekonsentreerde) swawelsuur* / H_2SO_4/catalyst ✓ and / en heat /hitte✓ (2)

2.2.6 The product will have a characteristic smell. / *Die produk sal 'n spesifieke reuk hê.*✓ (1)

2.3

Marking criteria / Nasienriglyne

- Use formula / *Gebruik formule* $n=\frac{m}{M}$ ✓
- Use 44 / 58 ($g\cdot mol^{-1}$)/ *Gebruik* 44/ 58 ($g\cdot mol^{-1}$) ✓
- Use mole ratio / *Gebruik molverhouding*: $n(C_4H_{10}) = \frac{2}{8}\, n(CO_2)$ ✓
- Use/*Gebruik* %purity/*suiwerheid*= $\frac{\text{pure substance/}\textit{suiwer stof}}{\text{impure substance/}\textit{onsuiwer stof}} \times 100$✓
- Final answer/*Finale antwoord:* 43,1 % (43,098%)✓ (43,08 – 43,1)

$n=\frac{m}{M}$ ✓

$=\frac{34}{44}$ ✓

$n(CO_2) = 0{,}7727$ mol

$n(C_4H_{10}) = \frac{2}{8}\, n(CO_2) = 0{,}1932$ mol✓

$n=\frac{m}{M}$

$0{,}1932 = \frac{m}{58}$

$m(CO_2)=11{,}2056$ g

% purity/suiwerheid= $\frac{\text{pure substance/}\textit{suiwer stof}}{\text{impure substance/}\textit{onsuiwer stof}}$

$= \frac{11{,}2056}{26} \times 100$✓

$= 43{,}1\ (43{,}098)\%$ ✓

(5)
[18]

QUESTION 3 / VRAAG 3

3.1 A series of organic compounds that can be described by the same general formula OR in which one member differs from the next with a CH_2 group.✓✓

Reeks organiese verbindings wat deur dieselfde algemene formule beskryf kan word OF waarin die een lid van die volgende verskil met 'n CH_2groep. (2)

3.2.1 Boiling point/ *kookpunt* ✓ (1)

3.2.2
- Compound **B** is less branched/compact/spherical/smaller surface area than compound **A** and more branched/compact/spherical/smaller surface area than compound **C**. ✓

  OR

  A is the most branched/compact/spherical/smallest surface area and **C** is the least branched/compact/spherical/largest surface area.
- Intermolecular forces in compound **B** are stronger than in compound **A** and weaker than in compound **C**. ✓
- More energy needed to overcome the intermolecular forces in compound **B** than in compound **A** and less energy needed to overcome intermolecular forces in compound **C** than in compound **B.** ✓

  OR
- Compound **B** has a longer chain length than compound **A** and a shorter chain length than compound **C**. ✓
- Intermolecular forces increase with increase in chain length. ✓
- More energy needed to overcome intermolecular forces as chain length increases.✓

- *Verbinding **B** is minder vertak/kompak/sferiese oppervlak as verbinding **A** en meer vertak as verbinding **C**.* ✓

  OF

  ***A** is die meeste vertak/kompak en **C** die minste vertak/kompak/sferies/oppervlakte*
- *Intermolekulêre kragte in verbinding **B** is sterker as in verbinding **A** en swakker as in verbinding **C**.* ✓
- *Meer energie word benodig om die intermolekulêre kragte in verbinding **B** te oorkom as in verbinding **A** en minder energie word benodig om intermolekulêre kragte te oorkom in verbinding **C** as in verbinding **B**.* ✓

  OF
- *Verbinding **B** het 'n langer kettinglengte as verbinding **A** en 'n korter kettinglengte as in verbinding **C**.* ✓
- *Intermolekulêre kragte neem toe met toename in kettinglengte.* ✓
- *Meer energie word benodig om intermolekulêre kragte te oorkom wanneer kettinglengte toeneem.*✓ (3)

3.3.1

Criteria for investigative question / *Riglyne vir ondersoekende vraag*	
The dependent and independent variables are stated. *Die afhanklike en onafhanklike veranderlikes is genoem.*	✓
Ask a question about the relationship between the independent and dependent variables. *Vra 'n vraag oor die verwantskap tussen die onafhanklike en afhanklike veranderlikes*.	✓

Examples / Voorbeelde:

- How does the type of homologues series / compound influence the boiling point?
  Hoe sal die tipe homoloë reeks/ tipe verbinding die kookpunt beïnvloed?
- What is the relationship between type of compound / type of homologues series and boiling point?
- Wat is die verwantskap tussen tipe verbinding / homoloë reeks en die kookpunt? (2)

3.3.2

- Both compounds/**P** and **Q** have (in addition to London forces and dipole-dipole forces) hydrogen bonding.✓
- Compound **P**/$CH_3CH_2CH_2CH_2OH$/butan-1-ol/alcohol has one site for hydrogen bonding and compound **Q**/propanoic acid/carboxylic acid has two/more sites for hydrogen bonding. ✓
- Intermolecular forces in compound ***Q****/propanoic acid/carboxylic acid* are stronger than intermolecular forces in compound **P**/$CH_3CH_2CH_2CH_2OH$/butan-1-ol/ alcohol✓
- More energy is needed to overcome/break intermolecular forces in compound **Q**/propanoic acid/carboxylic acid than in **P**/$CH_3CH_2CH_2CH_2OH$/butan-1-ol/ alcohol✓

- *Beide verbindings/**P** en **Q** het waterstofbindings (behalwe Londonkragte en dipool-dipoolkragte).*
- *Verbinding **P**/$CH_3CH_2CH_2CH_2OH$/butan-1-ol/alkohol het een punt vir waterstofbindings en verbinding **Q**/propanoësuur/karboksielsuur het twee/meer punte vir waterstofbindings.*
- *Intermolekulêre kragte in verbinding **Q**/propanoësuur/karboksielsuur is sterker as die intermolekulêre kragte in verbinding **P**/$CH_3CH_2CH_2CH_2OH$/butan-1-ol/alkohol.*
- *Meer energie word benodig om intermolekulêre kragte in verbinding **Q**/propanoësuur as in verbinding **P**/ $CH_3CH_2CH_2CH_2OH$/butan-1-ol/alkohol te oorkom.* (4)

[12]

QUESTION 4/ *VRAAG 4*

4.1.1 Substitution/halogenation✓
Substitusie/halogenering/halogenasie (1)

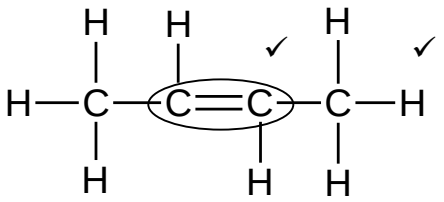
4.1.2 Substitution/Hydrolysis✓
Substitusie/Hidrolise (1)

4.1.3 Addition/Hydrogenation✓
Addisie/Hidrogenasie (1)

4.2.1 Concentrated strong base ✓and heat strongly. ✓
Gekonsentreerde sterk basis en verhit sterk. (2)

4.2.2 2-Bromo✓butane✓/*2-broombutaan/2-bromobutaan* (2)

4.2.3



Marking criteria / *Nasienriglyne*
- Functional group on second carbon/*funksionele groep op tweede koolstof* ✓
- Whole structure correct / *Hele struktuur korrek* ✓

(2)

4.3.1 Hydration / *Hidrasie* / *Hidratering* ✓ (1)

4.3.2 H_2SO_4/Sulphuric acid/*Swawelsuur* H_3PO_4/Phosphoric acid/*fosforsuur* ✓ (1)

4.4 NaBr/HBr✓ (1)
[12]

QUESTION 5/ *VRAAG 5*

5.1 $CO_2(g)$ is released to the surroundings / *$CO_2(g)$ word vrygestel aan die omgewing*✓ (1)

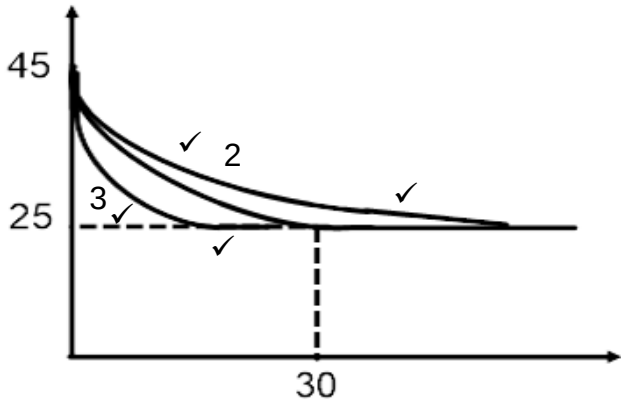
5.2 It is the <u>change in concentration of reactants or products</u>✓ <u>per unit time</u>.✓
Dit is die <u>verandering in konsentrasie van reaktante of produkte</u> per <u>eenheidstyd</u>.

> **<u>Notes / Aantekening:</u>**
>
> Allocate a mark on per <u>unit time</u> if used in the correct context / *'n <u>Punt</u> word slegs toegeken as <u>per eenheids tyd</u> in die regte konteks gebruik word.*

(2)

5.3 rate = $-\frac{\Delta m}{\Delta t}$
$= -\frac{25-45✓}{30-0✓}$
$= 0{,}67\ g\cdot s^{-1}$✓ (3)

5.4

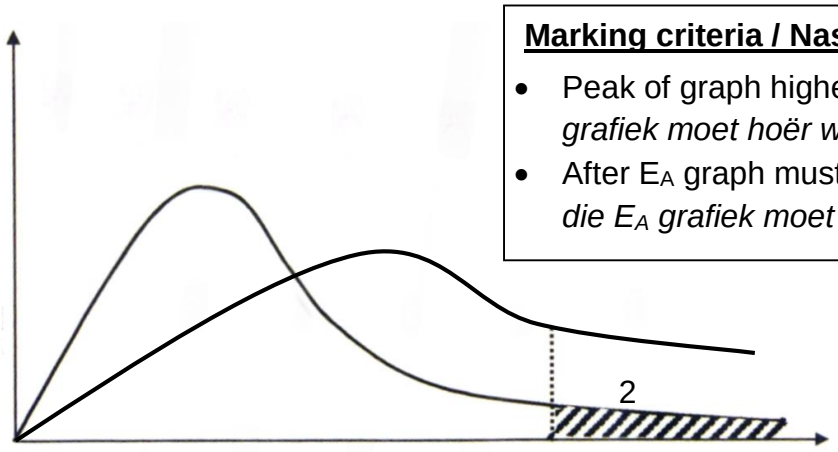


> **<u>Marking criteria / Nasienriglyne</u>**
>
- all gradients must start at 45 g and end at 25 g / *alle hellings moet by 45 g begin en eindig by 25 g*
- gradient 2 must be <u>less steep</u>✓ and end <u>after</u> 30s ✓/ *helling 2 moet minder styl wees en eindig na 30 s*
- gradient 3 must be <u>steeper</u> ✓and end <u>before</u> 30s✓/ *helling 3 moet styler wees en eindig voor 30 s*

(4)

5.5 Concentration of HCl increases./ *Konsentrasie van HCl verhoog*✓
More particles per unit volume / *Meer deeltjies per eenheids volume* ✓
More particles collide with the correct orientation/*Meer deeltjies bots met die regte orientasie.* ✓
More effective collisions per unit time / *meer effektiewe botsings per eenheid tyd*. ✓ (4)

5.6



Marking criteria / Nasienriglyne

- Peak of graph higher./ *Kruin van grafiek moet hoër wees.* ✓
- After E_A graph must be below / *Na die E_A grafiek moet onder wees* ✓

(2)
[16]

QUESTION 6 / *VRAAG 6*

6.1.1 No / *Nee* ✓

Equilibrium is not reached yet / *Ewewig is nog nie bereik nie*. ✓ (2)

6.1.2
- Concentration of O_2 decreased / *Konsentrasie van O_2 verlaag*. ✓
- The reaction that increased the decreased concentration was favoured. ✓
- The reverse reaction was favoured. ✓
- The amount/concentration of reactants increased/ The amount/concentration of products decreased. ✓

(4)

6.1.3 Exothermic ✓
A decrease in temperature favours the exothermic reaction, the forward reaction was favoured OR [H_2O] and [NO] increased. ✓

(2)

6.2.1 **CALCULATIONS USING NUMBER OF MOLES / *BEREKENINGE WAT ANTALE MOLE GEBRUIK***

Marking criteria / Nasienriglyne

- Use ratio/*gebruik verhouding* 1:1:1
- Multiply and/or Divide by 2 dm^3.
- Correct Kc expression/ *Korrekte Kc uitdrukking*
- Substitution of consentration into Kc expression /*Vervanging van konsentrasie in Kc uitdrukking*
- Final answer / *Finale antwoord.* 0,357

	$PC\ell_5$	$PC\ell_3$	$C\ell_2$
Initial quantity (mol) Aanvangshoeveelheid (mol)	2,4	0	0
Change (mol) *Verandering (mol)*	-1,0	+1,0	+1,0
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	1,4	1,0	1,0
Equilibrium concentration ($mol \cdot dm^{-3}$) Ewewigskonsentrasie ($mol \cdot dm^{-3}$)	0,7	0,5	0,5

Ratio ✓

Mutiply/divide by 2 ✓

$$Kc = \frac{[PC\ell_3][C\ell_2]}{[PC\ell_5]} \quad ✓$$

$$= \frac{(0,5)(0,5)}{(0,7)} \quad ✓$$

$$= 0,357 ✓$$

No Kc expression, correct substitution / *Geen Kc uitdrukking, korrekte substitusie:* Max. / *Maks* $^4/_5$

Wrong Kc expression / *Verkeerde Kc uitdrukking*: Max./*Maks*. $^2/_5$

(5)

6.2.1 **CALCULATIONS USING CONCENTRATION / *BEREKENINGE WAT KONSENTRASIE GEBRUIK***

(4)

Marking criteria / Nasienriglyne

- Use ratio/*gebruik verhouding* 1:1:1
- Divide by 2 dm^3 on $PC\ell_3$
- Correct Kc expression/ *Korrekte Kc uitdrukking*
- Substitution of consentration into Kc expression /*Vervanging van konsentrasie in Kc uitdrukking*
- Final answer / *Finale antwoord.* 0,357

	$PC\ell_5$	$PC\ell_3$	$C\ell_2$
Initial concentration ($mol \cdot dm^{-3}$) *Aanvanklike konsentrasie ($mol \cdot dm^{-3}$)*	1,2	0	0
Change ($mol \cdot dm^{-3}$) *Verandering ($mol \cdot dm^{-3}$)*	-0,5	+0,5	+0,5
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,7	0,5	0,5

Ratio ✓

Divide by 2 ✓

$$Kc = \frac{[PC\ell_3][C\ell_2]}{[PC\ell_5]} \quad ✓$$

$= \frac{(0,5)(0,5)}{(0,7)}$ ✓

=0,357✓

No Kc expression, correct substitution / *Geen Kc uitdrukking, korrekte substitusie:* Max. / *Maks* $^4/_5$

Wrong Kc expression / *Verkeerde Kc uitdrukking*: Max./*Maks*. $^2/_5$

6.2.2 **OPTION 1**

$n = \frac{m}{M}$ ✓

$2,4$ ✓ $= \frac{m}{(208,5)}$ ✓

m = 500,4g ✓

Marking criteria / Nasienriglyne
• Formula / *Formule*
• substitution / *invervanging* 2,4 in n
• substitution / *invervanging* 208,5 in M
• final answer /*finale antwoord* 500,4g

(4)

OPTION 2

$c = \frac{m}{MV}$ ✓

$1,2$ ✓ $= \frac{m}{(208,5)(2)}$ ✓

m = 500,4g ✓

Marking criteria / Nasienriglyne
• Formula / *Formule*
• substitution / *invervanging* 1,2 in c
• substitution / *invervanging* 208,5 in M
• final answer /*finale antwoord* 500,4g

(4)

[17]

QUESTION 7

7.1.1 <u>It dissociates completely in water</u> ✓and <u>produces a high concentration of OH^- ions.</u> ✓/ <u>dissosieer volledig in water</u> om 'n <u>hoë konsentrasie OH^--ione te vorm.</u> (2)

7.1.2 $[OH^-] = 0,2\ mol{\cdot}dm^{-3}$ ✓

$[H_3O^+][OH^-] = 1 \times 10^{-14}$✓

$[H_3O^+](0,2) = 1 \times 10^{-14}$

$[H_3O^+] = 5 \times 10^{-14}\ mol{\cdot}dm^{-3}$

$pH = -\log [H_3O^+]$ ✓ +

$= -\log (5 \times 10^{-14})$ ✓

$= 13,3$ ✓ (5)

7.2.1 A standard solution is a solution of which the concentration is known. ✓✓ (2)

Marking Rule

- *Formula* $n = \frac{m}{M}$ or n = c x V
- *Substitute 0,25 dm^{-3}*
- *Substitute 126 g.mol^{-1}*
- *Final answer*

7.2.2 **Option 1:**

n = c x V ✓
= 0,2 x 0,25 ✓
= 0,05 mol

M[$(COOH)_2 \cdot 2H_2O$ = 126 g.mol^{-1}

M = n x M
= 0,05 x 126 ✓
= 6,3 g ✓

Marking Rule

- *Formula* m = cMV
- *Substitute 0,25 dm^3*
- *Substitute 66 g.mol^{-1}*

Option 2

m = c MV ✓
✓ ✓
= (0,2)(126)(0,25)
= 6,3 g ✓

(4)

7.3.1 The endpoint of a titration is the point where the indicator colour changes. ✓✓ (2)

7.3.2 GREATER THAN 7 ✓ (1)

7.3.3 38,8 – 2,8 = 36 cm^3 /0,036dm^3✓ (1)

7.3.4 $n(COOH)_2$ = c x V ✓
= 0,2 X 0,025 ✓
= 5 x 10^{-3} mole
$n(COOH)_2$: n(NaOH) = 1 : 2 ✓

c(NaOH) = $\frac{n}{V}$

Marking Rule

- *Formula* $n = \frac{m}{M}$ or n = c x V
- *Substitute 0,025 dm^3*
- *Ratio 1:2*
- *Correct substitution in* c(NaOH) = $\frac{n}{V}$
- *Final answer*

(5)

$= \frac{0,01}{0,036}$ ✓

$= 0,28\ mol{\cdot}dm^{-3}$ ✓

[22]

QUESTION 8

8.1 $Cu + C\ell_2$ ✓ $\rightarrow Cu^{2+} + 2C\ell^-$ ✓ Balancing: ✓ (3)

8.2 $E°_{cell} = E°_{reduction} - E°_{oxidation}$ ✓
$= 1,36$ ✓ $- 0,34$ ✓
$= 1,02\ V$ ✓

Notes/*Aantekeninge*
- Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.*
- Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E°_{sel} = E°_{OM} - E°_{RM}$ *gevolg deur korrekte vervangings:* $^3/_4$

(4)

8.3 Pt ✓ (1)

8.4 The cations (positive ions) move to the $C\ell_2/C\ell^-$ half-cell ✓ and the anions move to the Cu/Cu^{2+} half-cell. ✓ (2)

[10]

QUESTION 9

9.1 Bauxite ✓ (1)

9.2 It is a cell in which electrical energy is converted in chemical energy. ✓✓ (2)

9.3 $A\ell^{3+}$ ✓ and O^{2-} ✓ (2)

9.4 It <u>decreases the melting point</u> ✓of the alumina and therefor reduces the amount of electricity needed to melt the alumina. (1)

9.5 $A\ell^{3+} + 3e^- \rightarrow A\ell$ ✓✓ (2)

9.6 The <u>O_2</u> that forms ✓at the carbon cathode, <u>reacts with the carbon</u> ✓to form CO_2.
$C + O_2 \rightarrow CO_2$ ✓ (3)

[11]

QUESTION 10

10.1 Sulphur/*Swael*/S ✓ (1)

10.2 Vanadium pentoxide/*Vanadium pentoksied*✓ (1)

10.3.1 Oleum✓ (1)

10.3.2 The reaction is highly exothermic/it forms a fine mist which is difficult to collect.✓✓ (2)

10.4 $2NH_3 + H_2SO_4$ ✓→ $(NH_4)_2SO_4$✓ Balancing: ✓ (3)

10.5 $\frac{2}{6}$✓ x 22 = 7,333 % ✓

$\frac{7,333}{100}$ x 40 = 2.93 kg ✓

(3)

[11]

TOTAL: 150