basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 11

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2014

MEMORANDUM

MARKS/*PUNTE*: 150

This memorandum consists of 14 pages./
Hierdie memorandum bestaan uit 14 bladsye.

QUESTION 1/*VRAAG 1*

1.1 C ✓✓ (2)

1.2 C ✓✓ (2)

1.3 B ✓✓ (2)

1.4 A ✓✓ (2)

1.5 C ✓✓ (2)

1.6 D ✓✓ (2)

1.7 B ✓✓ (2)

1.8 C ✓✓ (2)

1.9 C ✓✓ (2)

1.10 B ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1 The (average) distance between nuclei ✓
of two bonded atoms in a molecule. ✓
Die (gemiddelde) afstand tussen kerne van twee gebinde atome in 'n molekuul. (2)

2.2

2.2.1 60 (pm) ✓✓ (2)

2.2.2 350 ($kJ \cdot mol^{-1}$) ✓✓ (2)

2.2.3 Bond energy ✓
Bindingsenergie (1)

2.3 Shorter than ✓
F atoms are smaller than Br atoms and come closer to H atom. ✓
Korter as
F-atome is kleiner as Br-atome en kom nader aan H-atoom. (2)
[9]

QUESTION 3/*VRAAG 3*

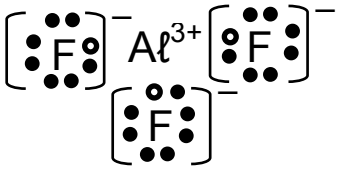
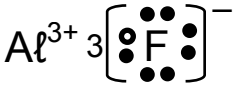
3.1 A covalent bond is a sharing of electrons between two atoms ✓
whilst an ionic bond forms when electrons are transferred from one atom to another and oppositely charged ions attract each other. ✓
'n Kovalente binding is die deling van elektrone tussen twee atome terwyl 'n ioniese binding vorm wanneer elektrone oorgedra word van een atoom na 'n ander en teenoorgesteld gelaaide ione mekaar aantrek. (2)

3.2

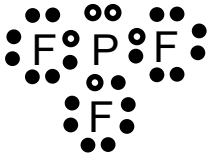
3.2.1 Ionic bond ✓
Ioniese binding (1)

3.2.2 Covalent bond ✓
Kovalente binding (1)

3.3

3.3.1  ✓✓ **OR/*OF*** 

Marking criteria/*Nasienriglyne:*
- Symbol of one $A\ell^{3+}$ ion shown – no electrons around it. ✓
  Simbool van een $A\ell^{3+}$-ioon getoon – geen elektrone rondom dit.
- Symbol of F^- ion shown with 8 electrons around it. ✓
  Simbool van F^--ioon getoon met 8 elektrone rondom dit.
- Three F^- ions included in structure.
  Drie F^--ione ingesluit in die struktuur. (3)

3.3.2  ✓✓

Marking criteria/*Nasienriglyne:*
- Symbols of one P atom and three F atoms shown with two electrons shown as dots/crosses between them. ✓
  Simbole van een P-atoom en drie F-atome getoon met twee elektrone aangedui as kolle/kruise tussen hulle.
- Three lone pairs placed around each F atom and one lone pair placed around P atom. ✓
  Drie alleenpare geplaas rondom elke F-atoom en een alleenpaar geplaas rondom P-atoom. (2)

3.4 Pyramidal ✓
Piramidaal (1)

3.5 The ionic bonds between particles in AlF_3 ✓ are stronger than ✓ the intermolecular forces/Van der Waals forces/dipole-dipole forces between molecules in PF_3. ✓
Die ioniese bindings tussen deeltjies in AlF_3 is sterker as die intermoleklêre kragte/Van der Waalskragte/dipool-dipoolkragte tussen molekule in PF_3.
More energy needed to overcome ionic bonds in AlF_3 than the intermolecular forces/Van der Waals forces/dipole-dipole forces in PF_3. ✓
Meer energie nodig om die ioniese bindings in AlF_3 te oorkom as die intermolekulêre kragte/Van der Waalskragte/dipool-dipoolkragte tussen molekule in PF_3. (4)
[14]

QUESTION 4/*VRAAG 4*

4.1 The temperature ✓
at which the vapour pressure of a liquid equals external (atmospheric) pressure. ✓
Die temperatuur waarby die dampdruk van 'n vloeistof gelyk is aan die eksterne (atmosferiese) druk. (2)

4.2

4.2.1
- Between molecules of P are weak London forces/dispersion forces/ induced dipole forces. ✓
  Tussen molekule van P is swak London-kragte/dispersiekragte/ geïnduseerde dipoolkragte.
- Between molecules of Q are strong hydrogen bonds. ✓
  Tussen molekule van Q is sterk waterstofbindings.
- Hydrogen bonds are stronger than London forces/dispersion forces/ induced dipole forces. ✓
  Waterstofbindings is sterker as London-kragte/dispersiekragte/ geïnduseerde dipoolkragte.
  OR/*OF*
  London forces/dispersion forces/induced dipole forces are weaker than hydrogen bonds.
  London-kragte/dispersiekragte/geïnduseerde dipoolkragte is swakker as waterstofbinding.
- More energy needed to overcome intermolecular forces in Q than in P. ✓
  Meer energie nodig om intermolekulêre kragte in Q as in P te oorkom.
  OR/*OF*
  Less energy needed to overcome intermolecular forces in P than in Q.
  Minder energie nodig om intermolekulêre kragte in P as in Q te oorkom. (4)

4.2.2
- Molecules of S are larger than those of P./Molecules of P smaller than those of S. ✓
  Molekule van S is groter as die van P./Molekule van P kleiner as die van S.
- London forces increase with increase in molecular size/mass. ✓
  London-kragte neem toe met toename in molekulêre grootte/massa.
- More energy needed to overcome intermolecular forces in S than in P. ✓
  Meer energie nodig om die intermolekulêre kragte in S as in P te oorkom.
  OR/*OF*
- Less energy needed to overcome intermolecular forces in P than in S.
  Minder energie nodig om die intermolekulêre kragte in P as in S te oorkom. (3)

4.3 Electronegtivity of oxygen is higher than that of nitrogen. ✓
Elektronegatiwiteit van suurstof is hoër as die van stikstof.
The water molecule is more polar than the ammonia molecule. ✓
Die watermolekuul is meer polêr as die ammoniakmolekuul. (2)

4.4
4.4.1 Q/R ✓ (1)

4.4.2 P/S ✓ (1)
[12]

QUESTION 5/*VRAAG 5*

5.1 Temperature of a gas is a measure of the average kinetic energy of the gas molecules. ✓
Temperatuur van 'n gas is 'n maatstaf van die gemiddelde kinetiese energie van die gasmolekule. (1)

5.2
5.2.1 The pressure (of a fixed mass of gas) is directly proportional to the temperature ✓
at constant volume. ✓
Die druk (van 'n vaste massa gas) is direk eweredig aan die temperatuur by konstante volume. (2)

5.2.2
$$\frac{p_1}{T_1} = \frac{p_2}{T_2} \checkmark$$
$$\frac{100}{298\checkmark} = \frac{150}{X} \checkmark$$
$$X = 447\ K$$
$$= 174\ °C\checkmark$$

Marking guidelines/*Nasienriglyne*:
- Formula/*Formule* ✓
- Substitution of/*Substitusie van* 298 K ✓
- Substitution of/*Substitusie van* 100 kPa and/*en* 150 kPa ✓
- Final answer/*Finale antwoord*: 174 °C✓

(4)

5.2.3
Gradient/*Gradiënt* = $\frac{p}{T}$ ✓

From/*Uit* pV = nRT: $\frac{p}{T} = nR$ ✓

For constant V/*Vir konstante V*, $\frac{p}{T} \alpha\ n$ ✓

For graph Q:
Smaller gradient implies smaller number of moles and thus smaller mass of gas. ✓
Vir grafiek Q:
Kleiner gradiënt impliseer kleiner aantal mol en dus kleiner massa gas. (4)

5.3

5.3.1 **Marking criteria/*Nasienriglyne:***

- Formula/*Formule*: pV = nRT ✓
- Substitution of pressure in Pa/*Substitusie van druk in Pa* ✓
- Substitution of volume in m^3/*Substitusie van volume in* m^3 ✓
- Substitution of/*Substitusie van* $\frac{2,2}{M}$ in pV = nRT **OR/*OF*** $n = \frac{2,2}{M}$ ✓
- Substitution of 300 K and 8,31/*Substitusie van 300 K en 8,31* ✓
- Final answer/*Final antwoord*: 44 g·mol^{-1} ✓

OPTION 1/*OPSIE 1*

pV = nRT ✓

(150×10^3) ✓ $(0,831 \times 10^{-3})$ ✓ $= \frac{2,2}{M}$ ✓ (8,31)(300) ✓

$\therefore$ M = 44 g·mol^{-1} ✓

OPTION 2/*OPSIE 2*

pV = nRT ✓

$$\therefore n = \frac{pV}{RT} = \frac{(150 \times 10^3)(0,831 \times 10^{-3})}{(8,31)(300)} \checkmark \checkmark$$

$$= 0,05 \text{ mol}$$

$$n = \frac{m}{M} \therefore 0,05 = \frac{2,2}{M} \checkmark$$

$\therefore$ M = 44 g·mol^{-1} ✓

Notes/*Aantekeninge:*

- If R = 8,3 was used, no mark is given for the substitution, but the mark for the answer can still be given.
  Indien R = 8,3 gebruik word, word geen punt vir substitusie gegee nie, maar die punt vir die antwoord kan steeds gegee word.

(6)

5.3.2 **POSITIVE MARKING FROM QUESTION 5.3.1.**
POSITIEWE NASIEN VAN VRAAG 5.3.1.

CO_2 /Carbon dioxide/*Koolstofdioksied* ✓
OR/*OF*
C_3H_8 /Propane/*Propaan* (1)

[18]

QUESTION 6/*VRAAG 6*

6.1 The mass of one mol (of the substance). ✓
Die massa van een mol (van die stof). (1)

6.2 $n(H_2O) = \frac{m}{M}$ ✓
$= \frac{100}{18}$ ✓
$= 5,56$ mol ✓ (3)

6.3
6.3.1 Smallest whole number ratio of the elements that make up the substance. ✓✓
Kleinste heelgetalverhouding van die elemente waaruit die stof bestaan. (2)

6.3.2 $\%C = (\frac{3,758}{5,325})(100) = 70,573$
$\%H = (\frac{0,316}{5,325})(100) = 5,934$
$\%O = (\frac{1,251}{5,325})(100) = 23,493$ ✓

$n = \frac{m}{M}$ ✓

$n(C) = \frac{70,573}{12✓} = 5,881$ mol

$n(H) = \frac{5,934}{1✓} = 5,934$ mol

$n(O) = \frac{23,493}{16✓} = 1,468$ mol

mol C : mol H : mol O = 4 : 4 : 1 ✓
∴ C_4H_4O ✓ (7)

Marking criteria/*Nasienriglyne:*
- Calculate % of three elements. ✓
  Bereken % van drie elemente.
- Formula/*Formule* $n = \frac{m}{M}$ ✓
- Use molar mass C ✓
  Gebruik molêre massa C
- Use molar mass H ✓
  Gebruik molêre massa H
- Use molar mass O ✓
  Gebruik molêre massa O
- Ratio/*Verhouding* ✓
- Empirical formula/*Empiriese formule*: C_4H_4O ✓

6.3.3 $M(C_4H_4O) = 4(12) + 4(1) + 16 = 68$ g·mol^{-1}
$\frac{136}{68} = 2$ ✓
∴ Molecular formula/*Molekulêre formule*: $C_8H_8O_2$ ✓

Notes/*Aantekeninge*:
- If correct formula without calculation - two marks
  Indien korrekte formule sonder berekening – twee punte.

(2)
[15]

QUESTION 7/*VRAAG 7*

7.1 A reactant whose amount limits/determines the amount of product obtained in a chemical reaction. ✓✓
Die reaktans waarvan die hoeveelheid die hoeveelheid produk wat in 'n chemiese reaksie verkry word, beperk/bepaal.

OR/*OF*
The reactant that produces the least amount of product. ✓✓
Die reaktans wat die minste hoeveelheid produk sal lewer.

OR/*OF*
The reactant that will be used up first during a chemical reaction. ✓✓
Die reaktans wat eerste opgebruik word tydens 'n chemiese reaksie. (2)

7.2
7.2.1

$$n(Fe) = \frac{m}{M}$$
$$= \frac{20}{56} \checkmark$$
$$= 0{,}357 \text{ mol Fe}$$

✓Any formula
Enige formule

$$n(S) = \frac{m}{M}$$
$$= \frac{10}{32} \checkmark$$
$$= 0{,}313 \text{ mol S}$$

From balanced equation/*Uit gebalanseerde vergelyking*:
1 mol Fe reacts with/*reageer met* 1 mol S ✓
n(S) < n(Fe)
The limiting reactant is S./*Die beperkende reaktans is S.* ✓ (5)

7.2.2 **POSITIVE MARKING FROM QUESTION 7.2.1.**
POSITIEWE NASIEN VAN VRAAG 7.2.1.

$$n(\text{Fe used / gebruik}) = \frac{m}{M}$$
$$0{,}313 = \frac{m}{56} \checkmark$$

∴ m(Fe used/*gebruik*) = 17,5 g

m(excess/*oormaat*) = 20 – 17,5 ✓ = 2,5 g ✓ (3)

7.3

Marking criteria/*Nasienriglyne:*

- Substitute/use M(MgO) = 40 g·mol^{-1} ✓
  Vervang/gebruik M(MgO) = 40 g·mol^{-1}
- Use ratio of n(Mg) : n(MgO) = 1 : 1 ✓
  Gebruik verhouding n(Mg) : n(MgO) = 1 : 1
- Use M(Mg) = 24 g·mol^{-1} ✓
  Gebruik M(Mg) = 24 g·mol^{-1}
- Calculate m(MgO) = 24 g or n(MgO) = 0,6 mol that will be obtained if 80% yield. ✓
  Bereken m(MgO) = 24 g of n(MgO) = 0,6 mol wat verkry sal word as 80% opbrengs.
- Calculate m(Mg) or n(Mg) needed. ✓
  Bereken m(Mg) of n(Mg) benodig.
- Final answer/*Finale antwoord*: 22,5 g ✓

OPTION 1/*OPSIE 1*

$$n(MgO) = \frac{m}{M}$$
$$= \frac{30}{40}\checkmark$$
$$= 0{,}75 \text{ mol}$$

From balanced equation/*Uit gebalanseerde vergelyking*:
n(Mg) = n(MgO) = 0,75 mol ✓

$$n(Mg) = \frac{m}{M}$$
$$0{,}75 = \frac{m}{24}\checkmark$$
$$m(Mg) = 18 \text{ g}$$

If 18 g Mg gives 80% yield, then mass Mg needed for 100% yield:
As 18 g Mg 80% gee, dan is massa Mg nodig vir 100%
18 g ……24 g MgO ✓
x g ……..30 g ✓

$$\therefore m(Mg) = \frac{(18)(30)}{24} = 22{,}5 \text{ g}\checkmark$$

OPTION 2/*OPSIE 2*

$$n(MgO) = \frac{m}{M}$$
$$= \frac{30}{40}\checkmark$$
$$= 0{,}75 \text{ mol}$$

From balanced equation/*Uit gebalanseerde vergelyking*:
n(Mg) = n(MgO) = 0,75 mol ✓

If 0,75 mol Mg gives 80% yield, then mol Mg needed for 100% yield:
As 0,75 mol Mg 80% gee, dan is mol Mg nodig vir 100%:
0,75 mol Mg ……..0,6 mol MgO ✓
x mol Mg……..0,75 mol Mg

$$n(Mg) = \frac{(0{,}75)(0{,}75)}{0{,}6}\checkmark$$
$$= 0{,}9375 \text{ mol}$$

$$n(Mg) = \frac{m}{M}$$
$$0{,}9375 = \frac{m}{24}\checkmark$$
$$\therefore m(Mg) = 22{,}5 \text{ g}\checkmark$$

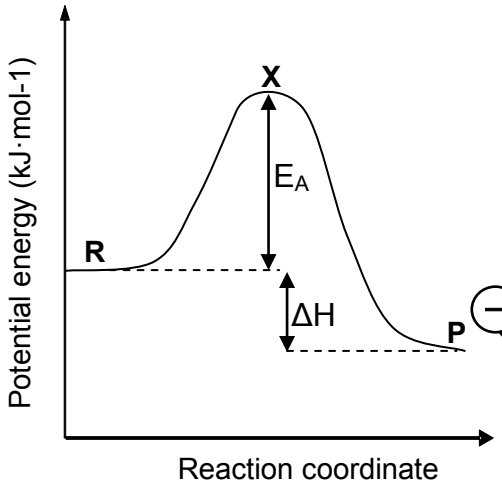
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
From balanced equation: *Uit gebalanseerde vergelyking:* 2 mol Mg ……..2 mol MgO 48 g Mg ✓……80 g ✓ MgO ✓ x g Mg ……..30 g MgO x = 18 g Mg If 30 g MgO is 80% yield, then Mg needed: *As 30 g MgO 80% opbrengs is, dan is Mg benodig:* 18 g ……24 g MgO ✓ x g ……..30 g $\therefore$ m(Mg) = $\frac{18 \times 30}{24}$ ✓ = 22,5 g ✓	$n(MgO) = \frac{m}{M} = \frac{30}{40\checkmark} = 0{,}75$ mol From balanced equation: *Uit gebalanseerde vergelyking:* n(Mg) = n(MgO) = 0,75 mol ✓ If 0,75 mol Mg gives 80% yield, then mol Mg needed for 100% yield: *As 0,75 mol Mg 80% gee, dan is mol Mg nodig vir 100% opbrengs:* n(Mg) = $(\frac{100}{80})(0{,}75)$ ✓✓= 0,9375 mol $n(Mg) = \frac{m}{M}$ ✓ $0{,}9375 = \frac{m}{24}$ $\therefore$ m(Mg) = 22,5 g ✓

(6)
[16]

QUESTION 8/*VRAAG 8*

8.1 The minimum energy needed ✓ for a reaction to take place. ✓ (2)
Die minimum energie nodig vir 'n reaksie om plaas te vind.

8.2



Marking guidelines/*Nasienriglyne:*	
Reactants and products correctly labelled. *Reaktanse en produkte korrek benoem.*	✓
Activated complex *Geaktiveerde kompleks*	✓
Correct shape as shown. *Korrekte vorm soos getoon.*	✓
ΔH correctly indicated. ΔH *korrek aangetoon.*	✓
E_A correctly indicated. E_A *korrek aangetoon*	✓

Note: If graph drawn for endothermic reaction:
Nota: *Indien grafiek geteken is vir endotermiese reaksie:* Max/*Maks.* $^2/_5$ (5)

8.3
8.3.1 - 241,8 kJ·mol^{-1} ✓ (1)

8.3.2 1 611,8 kJ·mol^{-1} ✓✓

IF: No unit or incorrect unit: Max. $^1/_2$
INDIEN: *Geen eenheid of foutiewe eenheid:* (2)

[10]

QUESTION 9/*VRAAG 9*

9.1

9.1.1 An acid forms hydronium ions/hydrogen ions/H_3O^+ ions/H^+ ions ✓
in solution. ✓ (2)
'n Suur vorm hidroniumione/waterstofione/H_3O^+-ione/H^+-ione in oplossing.

9.1.2 Basic ✓ (1)
Basies

9.1.3 $CaCO_3(s) + \underline{2}HC\ell(aq) \rightarrow CaC\ell_2(aq) + \underline{2}H_2O(\ell) + CO_2(g)$ ✓ (1)

9.2

9.2.1 A substance that can react as either acid or base in a chemical reaction. ✓✓ (2)
'n Stof wat as of 'n suur of 'n basis kan reageer in 'n chemiese reaksie.

9.2.2 HSO_4^- ✓ (1)

9.2.3 SO_4^{2-} ✓ (1)

9.3

9.3.1 Sodium nitrate ✓
Natriumnitraat (1)

9.3.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$c(HNO_3) = \frac{n}{V}$	$c(HNO_3) = \frac{n}{V}$
$0,1 = \frac{n}{20 \times 10^{-3}}$ ✓	$0,1 = \frac{n}{20 \times 10^{-3}}$ ✓
$n(HNO_3) = = 0,002$ mol	$n(HNO_3) = = 0,002$ mol
$\underline{n(Na_2CO_3) = ½n(HNO_3)}$ $= ½(0,002)$ $= 0,001$ mol ✓	$\underline{n(Na_2CO_3) = ½n(HNO_3)}$ $= ½(0,002)$ $= 0,001$ mol ✓
$n(Na_2CO_3 \text{ in } 250\ cm^3) = \frac{250}{25} \times 0,001$ ✓ $= 0,01$ mol	
$n(Na_2CO_3 \text{ in } 250\ cm^3) = \frac{m}{M}$	$n(Na_2CO_3 \text{ in } 250\ cm^3) = \frac{m}{M}$
$\therefore 0,01 = \frac{m}{106}$ ✓	$\therefore 0,01 = \frac{m}{106}$ ✓
$\therefore m = 1,06$ g ✓	$\therefore m = 1,06$ g ✓

(5)

[14]

QUESTION 10/*VRAAG 10*

10.1 Decrease in oxidation number. ✓✓
Afname in oksidasiegetal. (2)

10.2
10.2.1 Cu ✓ (1)

10.2.2 Cu ✓
Oxidation number of Cu increases ✓ from 0 to +2. ✓
Oksidasiegetal van Cu neem toe van 0 tot +2. (3)

10.2.3 NO_3^- / HNO_3 ✓
NO_3^- gains electrons to form NO_2. ✓
NO_3^- *kry elektrone by om* NO_2 *te vorm.* (2)

10.3 $Cu \rightarrow Cu^{2+} + 2e^-$ ✓ (oxidation/*oksidasie*)
$NO_3^- + 2H^+ + e^- \rightarrow NO_2 + H_2O$ ✓ (reduction/*reduksie*) x2
$Cu + 4H^+ + 2NO_3^-$ ✓ $\rightarrow Cu^{2+} + 2NO_2 + 2H_2O$ ✓ Bal. ✓ (5)
[13]

QUESTION 11/*VRAAG 11*

11.1
11.1.1 Gold: Witwatersrand and Northern Free State ✓
Goud: Witwatersrand en Noord-Vrystaat.
Iron: Northern Cape (Sishen) and Thabazimbi, Limpopo
Yster: Noord-Kaap (Sishen) en Thabazimbi, Limpopo
Phosphate/*Fosfaat*: Phalaborwa; Mpumalanga
Coal/*Steenkool*: Witbank; Waterberg; Highveld; Ermelo; Utrecht
Diamond/*Diamant*: Kimberley and Orange River Basin/*Oranjerivierbekken*
Copper: Mpumalanga, Northern Cape, Northwest
Koper: Mpumalanga, Noord-Kaap, Noordwes
Platinum: Rustenburg (Marikana mine/-*myn*)
Zinc: Northern Cape
Sink: Noord-Kaap
Chromium/*Chroom*: Rustenburg
Asbestos: Northern Cape
Asbes: Noord-Kaap
Manganese/*Mangaan*: Mpumalanga; Northern Cape/*Noord-Kaap* (1)

11.1.2 **Select the method used for the chosen mineral:**
Deep level undergound mining/Open-cast mining ✓
Kies die metode gebruik vir die gekose mineral
Myn diep ondergrond/Oopgroefmyn (1)

11.2

11.2.1 Creates jobs/*Skep we*rk ✓
A lot of money can be generated from mineral resources (economy of the country grows)./*Baie geld kan uit mineraalbronne gegenereer word (ekonomie van land groei).* ✓ (2)

11.2.2 **ANY TWO/*ENIGE TWEE*** ✓✓
- Destruction of natural ecosystem.
  Vernietiging van natuurlike ekosisteem.
- Moving of people from areas where they have lived for a long time.
  Verskuiwing van mense uit gebiede waar hulle reeds lank woon.
- Mining can make the surrounding land unstable and unsafe to build on.
  Mynbou kan die omliggende gebied onstabiel maak en onveilig om op te bou.
- Pollution as a result of energy needed for the extraction of the metal.
  Besoedeling as gevolg van energie benodig vir ontginning van metaal.
- The destruction of the surrounding landscape.
  Vernietiging van omliggende landskap. (2)

11.3 **ANY TWO/*ENIGE TWEE*:**
- Size of the ore body. ✓✓
  Grootte van ertsneerslag.
- Amount of mineral in the ore. ✓✓
  Hoeveelheid mineraal in erts.
- Depth at which the mineral is located influences the mine cost.
  Diepte waarop mineraal voorkom beïnvloed koste van myn.
- Price of mineral compared to the cost of mining.
  Prys van mineraal in vergelyking met koste van mynbou.
- Infrastructure available (housing for employees, roads, water, electricity, school, hospitals, etc).
  Beskikbare infrastruktuur (behuising vir werkers, paaie, water, elektrisiteit, skole, hospitale, ens.)
- Cost of establishing infrastructure.
  Koste van infrastruktuurontwikkeling. (4)

[10]

TOTAL/*TOTAAL*: 150