UNIVERSITEIT VAN PRETORIA

DEPARTEMENT CHEMIE
DEPARTMENT OF CHEMISTRY

CMY 117
SEMESTERTOETS 1 / *SEMESTER TEST 1*

DATUM / DATE:	2 Maart 2009	**EKSAMINATORE:**	Prof. S Lotz
TYD / TIME:	2½ ure / hours	**EXAMINERS:**	Prof. WJ Schoeman
PUNTE / MARKS:	120	**EKSTERN / EXTERNAL:**	Dr JB Laurens

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AFDELING A / *SECTION A*

VAN EN VOORLETTERS: Memorandum
SURNAME AND INITIALS:

REGISTRASIENOMMER: ---------- **GRAADKURSUS:** ----------
REGISTRATION NUMBER: ***DEGREE COURSE:***

HANDTEKENING / *SIGNATURE* : ----------

VRAAG QUESTION	PUNTE MARKS		EKSAMINATOR EXAMINER
1		12	
2		16	
3		20	
4		12	
TOTAAL:AFDELING A TOTAL:SECTION A		60	
TOTAAL:AFDELING B TOTAL:SECTION B		60	
TOTAAL / TOTAL		120	

Toepaslike inligting is aangeheg aan Afdeling B.
Alle antwoorde (berekeninge, sketse en diagramme) moet in ink gegee word in hierdie afdeling.
Alle berekeninge moet volledig getoon word.

Applicable information is attached to Section B.
All answers (calculations, sketches, and diagrams) must be given in ink in this section.
All calculations must be shown in full.

Vraag 1 Metingseenhede en Omskakelings [12]	Question 2 Units of Measurement [12]
1.1 Skakel 4.500 pg.ℓ^{-1} om na µg.mm^{-3}. Gee die antwoord in wetenskaplike notasie. [5]	1.1 Convert 4.500 pg.ℓ^{-1} to µg.mm^{-3}. Give the answer in scientific notation. [5]

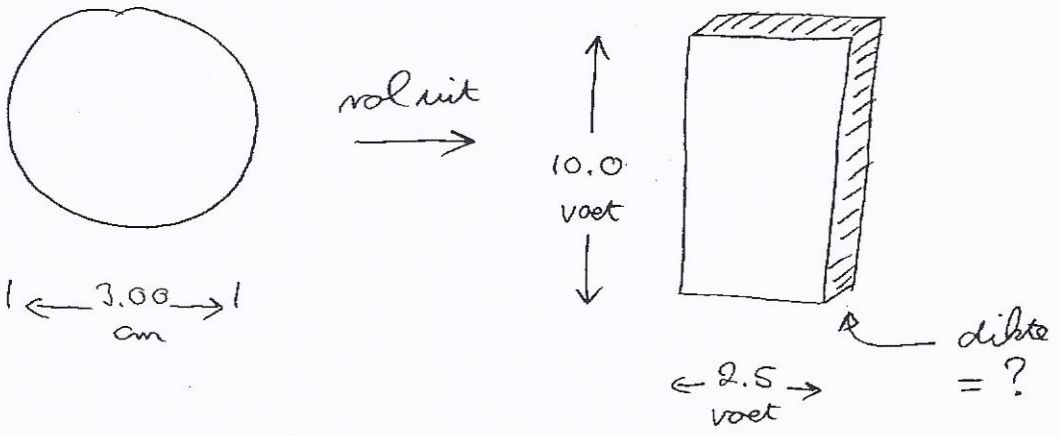
$$4.500\ \frac{pg}{\ell} = 4.500\ \frac{pg}{dm^3}$$

$$4.500\ \frac{pg}{dm^3} \times \frac{1\times10^{-12}\ g}{1\ pg} \times \frac{1\ \mu g}{1\times10^{-6}\ g} \times \left(\frac{1\ dm}{1\times10^{-1}\ m}\right)^3 \times \left(\frac{1\times10^{-3}\ m}{1\ mm}\right)^3$$

$$= 4.500 \times 10^{-12}\ \mu g.mm^{-3}$$

1.2 Goud is 'n sagte metaal wat uitgerol kan word in dun bladgoud. 'n Stuk suiwer goud, in die vorm van 'n sfeer, word volledig uitgerol as bladgoud. Die deursnit van die sfeer is 3.00 cm. Die bladgoud is reghoekig met afmetings 2.50 voet by 10.0 voet.
Bereken die dikte van die goudblad in µm.
Gebruik inligting op die datablad. [7]

1.2 Gold is a soft metal, which can be rolled out in thin gold leaf. A quantity of pure gold, in the form of a sphere, is completely rolled out in gold leaf. The diameter of the sphere is 3.00 cm. The gold leaf is rectangular with dimensions 2.50 feet by 10.0 feet.
Calculate the thickness of the gold leaf in µm.
Use information from the data sheet. [7]



1. Volume van bal $= \frac{4}{3}\pi r^3$

$= \frac{4}{3} \cdot \pi \cdot \left(\frac{3.00}{2}\right)^3$

$= 14.1\ cm^3$

2. Dus, volume van goudblad is ook $14.1\ cm^3$.

3. Volume van goudblad = lengte × breedte × dikte

$\Rightarrow 14.1 = \left(10.0\ vt \times \frac{12\ duim}{1\ vt} \times \frac{2.54\ cm}{1\ duim}\right) \times \left(2.5\ vt \times \frac{12\ duim}{1\ vt} \times \frac{2.54\ cm}{1\ duim}\right) \times dikte$

$\Rightarrow dikte = 6.07 \times 10^{-4}\ cm$

4. $6.07 \times 10^{-4}\ cm \times \frac{1 \times 10^{-2}\ m}{1\ cm} \times \frac{1\ \mu m}{1 \times 10^{-6}\ m} = 6.07\ \mu m.$

[3]

Vraag 2 Mol en Chemiese Formules [16]	Question 2 Mole and Chemical Formulas [16]
2.1 Natriumkarbonaat kom gewoonlik voor as die dekahidraat, $Na_2CO_3 \cdot 10H_2O(s)$. Wanneer 4.562 g hiervan in 'n oond by 80°C vir 4 uur verhit word, word gevind dat 'n ander hidraat van natriumkarbonaat vorm. Die massa daarvan is 2.551 g. Bereken die formule van die tweede hidraat. [8]	2.1 Normally sodium carbonate exists as the decahydrate, $Na_2CO_3 \cdot 10H_2O(s)$. When 4.562 g of this is heated in an oven at 80°C for 4 hours, it is found that another hydrate of sodium carbonate forms. The mass of this is 2.551 g. Calculate the formula of the second hydrate. [8]

Reaction :

$$\underbrace{Na_2CO_3 \cdot 10H_2O_{(s)}}_{4.562\,g} \xrightarrow{\Delta} \underbrace{Na_2CO_3 \cdot xH_2O_{(s)}}_{2.551\,g} + H_2O_{(g)}$$

286.19 g/mol

18.02 g/mol

1. $mass(H_2O) = (4.562 - 2.551)\,g = 2.011\,g$ } not necessary in this method

2. $n(H_2O) = \frac{2.011}{18.02} = 0.1116\ mol$ } not necessary in this method

3. $n(Na_2CO_3 \cdot 10H_2O) = \frac{4.562}{286.19} = 0.01594\ mol$

4. Thus, $n(Na_2CO_3 \cdot xH_2O)$ is also $= 0.01594\ mol$
(reaction ratio is 1:1)

5. $M(Na_2CO_3 \cdot xH_2O) = \frac{mass}{moles} = \frac{2.551}{0.01594}$

$= 160.03\ g/mol$

6. $M(Na_2CO_3) = 105.99\ g/mol$

7. Thus, contribution of the xH_2O in $Na_2CO_3 \cdot xH_2O$
$= (160.03 - 105.99) = 54.04\ g/mol$

8 $\Rightarrow x = \frac{54.04}{18.02} = 3 \Rightarrow Na_2CO_3 \cdot 3H_2O$ →

Vraag 2 Mol en Chemiese Formules [16]	Question 2 Mole and Chemical Formulas [16]
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[3]

Alternative method

1. % H_2O in the decahydrate $= \frac{10 \times 18.02}{286.19} \times 100$

$= 62.97\%$

2. mass (H_2O) in the decahydrate $= 0.6297 \times 4.562$

$= 2.872\ g$

3. mass (H_2O) removed during heating

$= (4.562 - 2.551)\ g$

$= 2.011\ g$

4. mass (H_2O) present in the new hydrate

$= (2.872 - 2.011)$

$= 0.861\ g$

5. $n(H_2O)$ present in the new hydrate

$= \frac{0.861}{18.02} = 0.0478\ mol$

6. $n(Na_2CO_3)$ in the new hydrate

$= n(Na_2CO_3)$ in the decahydrate $= \frac{4.562}{286.19}$

$= 0.01594\ mol$

7. Thus, for the new hydrate:

$(Na_2CO_3)_{0.01594}(H_2O)_{0.0478} \Rightarrow (Na_2CO_3)_1(H_2O)_3$

$\Rightarrow Na_2CO_3 \cdot 3H_2O.$

2.2 'n Onbekende verbinding bestaan uit die elemente koolstof, waterstof en suurstof.
Verbrandingsanalise van 4.5000 g van hierdie verbinding lewer 9.201 g koolsuurgas en 2.825 g waterdamp.
Dit is verder ook bekend dat die molêre massa van hierdie verbinding 258.30 $g.mol^{-1}$ is.
Bereken die empiriese en molekulêre formules van hierdie verbinding. [8]

2.2 An unknown compound consists of the elements carbon, hydrogen and oxygen.
Combustion analysis of 4.5000 g of this compound yields 9.201 g of carbon dioxide and 2.825 g of water vapour.
Furthermore, the molar mass of this compound is known to be 258.30 $g.mol^{-1}$.
Calculate the empirical and molecular formulas of this compound. [8]

$C_x H_y O_z + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$

4.5000 g — 9.201 g — 2.825 g

258.30 g/mol — 44.01 g/mol — 18.02 g/mol

CO_2 : $n(CO_2) = \frac{9.201}{44.01} = 0.2091$ mol

$\Rightarrow n(C) = 0.2091$ mol

and mass (C) $= 0.2091 \times 12.01 = 2.511$ g

H_2O : $n(H_2O) = \frac{2.825}{18.02}$

$\Rightarrow n(H) = \frac{2.825 \times 2}{18.02} = 0.3135$ mol

and mass (H) $= 0.3135 \times 1.01 = 0.3167$ g

O in the unknown compound :

mass(O) $= 4.5000 - 2.511 - 0.3167 = 1.672$ g

$n(O) = \frac{1.672}{16.00} = 0.1045$ mol

Empirical formula : $C_{0.2091} H_{0.3135} O_{0.1045}$

$\equiv C_2 H_3 O$

Molecular formula : factor $= \frac{258.30}{M(C_2H_3O)}$

$= \frac{258.30}{43.05} = 6$

$\Rightarrow C_{12} H_{18} O_6$

Semester toets 1 by -ons (2)

Vraag 3 Stoigiometrie en Neerslag [20]	Question 3 Stoichiometry and Precipitation [20]

(43/50)

3.1 Beskou die volgende ongebalanseerde reaksievergelyking:

$$TiO_2(s) + BrF_3(\ell) \rightarrow TiF_4(s) + Br_2(\ell) + O_2(g)$$

150.0 g van elk van die reagense word gemeng.

3.1.1 Bereken watter massa broom vorm as aangeneem word dat die reaksie 100% verloop. [7]

3.1 Consider the following unbalanced reaction equation:

$$TiO_2(s) + BrF_3(\ell) \rightarrow TiF_4(s) + Br_2(\ell) + O_2(g)$$

150.0 g of each of the reagents are mixed.

3.1.1 Calculate what mass of bromine will form if it is assumed that the reaction takes place 100%. [7]

79.87 g/mol 136.90 g/mol 159.80 g/mol

Vergelyking: $3\,TiO_{2(s)} + 4\,BrF_{3(\ell)} \rightarrow 3\,TiF_{4(s)} + 2\,Br_{2(\ell)} + 3O_{2(g)}$

150.0 g 150.0 g

1. BrF_3 is die beperkende reagens.
(Toon dit aan op enige manier)

2. 4 mol BrF_3 lewer 2 mol Br_2
$\Rightarrow$ 1 mol " " $\frac{1}{2}$ " "
$\Rightarrow \left(\frac{150.0}{136.90}\right)$ mol BrF_3 lewer $\left(\frac{1}{2} \times \frac{150.0}{136.90}\right)$ mol Br_2
$= 0.5478$ mol

3. massa $(Br_2) = 0.5478 \times 159.80 = 87.55$ g

3.1.2 Slegs 23 g suurstofgas word gevorm. Bereken wat die persentasie opbrengs van hierdie reaksie t.o.v. suurstof is. [5]

3.1.2 It was found that only 23 g of oxygen gas formed. Calculate the percent yield of this reaction with reference to oxygen. [5]

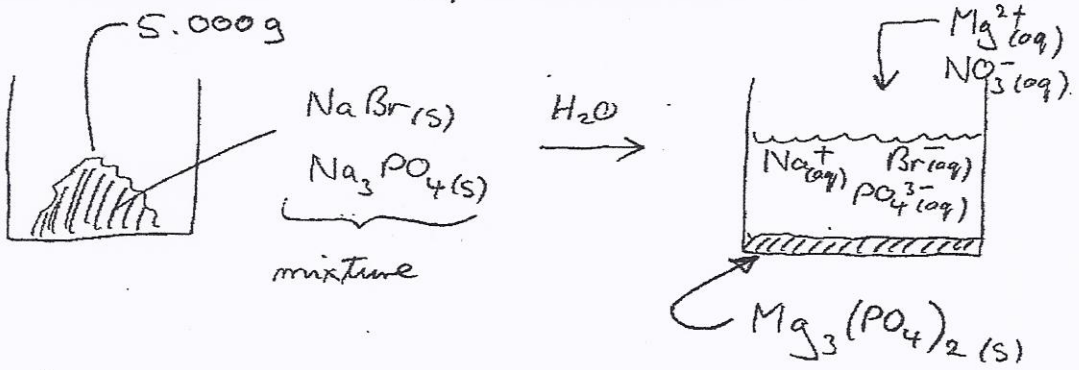
1. 4 moles BrF_3 yield 3 moles O_2
1 " " " $\frac{3}{4}$ " "
$\left(\frac{150.0}{136.90}\right)$ " " " $\left(\frac{3}{4} \times \frac{150.0}{136.90}\right)$ moles O_2
$= 0.8218$ mol

2. mass of O_2 expected $= 0.8218 \times 32.00$
$= 26.30$ g

3. % yield $= \frac{23}{26.30} \times 100 = 87\%$

3.2 'n Mengsel bestaan uit vaste natriumbromied en vaste natriumfosfaat. 5.000 g van hierdie mengsel word volledig in 'n hoeveelheid gedistilleerde water opgelos. 'n Oplossing van magnesiumnitraat word drupsgewys bygevoeg totdat geen verdere neerslag meer gevorm word nie.
Die neerslag word afgefiltreer, gedroog en geweeg. Die massa daarvan is 2.731 g.
Bepaal hieruit die persentasie natriumbromied in die oorspronklike vaste mengsel. [8]

3.2 A mixture consists of solid sodium bromide and solid sodium phosphate. 5.000 g of this mixture was dissolved in a quantity of distilled water.
A solution of magnesium nitrate was added drop-wise to the first solution until no further precipitate was formed.
The precipitate was filtered off, dried, and weighed.
The mass was found to be 2.731 g.
From this, determine the percentage sodium bromide in the solid mixture. [8]



Precipitation reaction:

$3\,Mg^{2+}_{(aq)} + 2\,PO^{3-}_{4\,(aq)} \longrightarrow Mg_3(PO_4)_2 \downarrow$

2.731 g

262.87 g.mol^{-1}

1. $n(Mg_3(PO_4)_2) = \frac{2.731}{262.87} = 0.01039$ mol
2. $n(PO_4^{3-}) = 0.01039 \times 2 = 0.02078$ mol
3. Thus, $n(Na_3PO_4) = 0.02078$ mol. Reason: all phosphate comes from Na_3PO_4.
4. mass $(Na_3PO_4) = 0.02078 \times 163.94$
   $= 3.406$ g
5. mass (NaBr) in mixture $= (5.000 - 3.406)$
   $= 1.594$ g
6. % NaBr $= \frac{1.594}{5.000} \times 100 = 31.87\%$

Vraag 4 Waterige Oplossings [12]	Question 4 Aqueous Solutions [12]

[5]

4.1 Skryf en voltooi die volgende chemiese reaksievergelykings. Skryf die fases by elke chemiese spesie en balanseer die vergelykings.

Write and complete the following chemical reaction equations. Write the phase of each chemical species and balance the equations.

Waterige oplossings van die volgende word in elke geval saamgevoeg:

Aqueous solutions of the following are added together in each case:

4.1.1 Chloorsuur en aluminiumhidroksied.

Chloric acid and aluminium hydroxide.

$3\,HClO_{3(aq)} + Al(OH)_{3(aq)} \rightarrow 3H_2O_{(l)} + Al(ClO_3)_{3(aq)}$ [3]

of $\rightarrow 3H_2O_{(l)} + Al^{3+}_{(aq)} + 3\,ClO^-_{3(aq)}$

4.1.2 Salpetersuur en natriumsulfied.

Nitric acid and sodium sulphide.

$2\,HNO_{3(aq)} + Na_2S_{(s)} \rightarrow H_2S_{(g)} + 2\,NaNO_{3(aq)}$ [3]

of $\rightarrow H_2S_{(g)} + 2Na^+_{(aq)} + 2NO^-_{3(aq)}$

4.1.3 Perchloorsuur en magnesiumkarbonaat.

Perchloric acid and magnesium carbonate.

$2\,HClO_{4(aq)} + MgCO_{3(aq)} \rightarrow H_2O_{(l)} + CO_{2(g)} + Mg(ClO_4)_{2(aq)}$ [3]

4.1.4 Ammoniumfosfaat en kalsiumnitraat

Ammonium phosphate and calcium nitrate.

$2(NH_4)_3PO_{4(aq)} + 3Ca(NO_3)_{2(aq)} \rightarrow Ca_3(PO_4)_{2(s)} + 6\,NH_4NO_{3(aq)}$ [3]

CMY 117
Semestertoets 1
2 Maart 2009

Memorandum: Afdeling B

Vraag	Antwoord	Punte
2	C	2
3	C	2
4	E	2
5	D	2
6	A	2
7	E	2
8	B	2
9	A	2
10	D	2
11	A	2
12	B	2
13	C	2
14	E	2
15	B	2
16	D	3
17	B	3
18	A	3
19	G	4
20	G	4
21	D	4
22	D	3
23	H	4
24	E	2
25	B	2

60

Praktika

26	C	2
27	A	2
28	E	2
29	C	2
30	A	2
31	E	2
32	B	2
33	E	2
34	C	2
35	B	2

20