DEPARTEMENT CHEMIE
DEPARTMENT OF CHEMISTRY

100 1908 - 2008

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

(+)

CMY 117

SEMESTERTOETS 2 / SEMESTER TEST 2

AFDELING A / SECTION A

DATUM / DATE: 20 April 2009
TYD / TIME: 2½ uur / hours
PUNTE / MARKS: 120

EKSAMINATORE / EXAMINERS: Prof. S Lotz
Prof. WJ Schoeman
Mr. MD Molefe
Dr. JB Laurens
Mrs. BA Castleman
Mrs. AC Botha
Mr. NJ de Beer

****

VAN EN VOORLETTERS: Memorandum
SURNAME AND INITIALS:

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

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

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

INSTRUKSIES		INSTRUCTIONS	
1.	'n Datablad is aangeheg aan Afdeling B.	1.	An information sheet is attached to Section B.
2.	Alle antwoorde (berekeninge, diagramme, Lewisstrukture) moet in ink gegee word. Antwoorde in potlood word nie aanvaar nie.	2.	All answers (calculations, diagrams, Lewis structures) must be given in ink. Answers in pencil will not be accepted.
3.	Alle berekeninge moet volledig getoon word. Alle stappe moet gegee word.	3.	All calculations must be shown in full. All steps must be given.
4.	Die korrekte aantal betekenisvolle syfers moet deurgaans in alle berekeninge gegee word.	4.	The correct number of significant figures must be given throughout in all calculations.

Vraag 1 Oplossingkonsentrasie en Titrasies [20]	Question 1 Solution Concentration and Titrations [20]

[5]

1.1 'n Oplossing bestaan uit ammoniumsulfied en ammoniumsulfaat, met konsentrasies 0.100 mol.dm^{-3} en 0.200 mol.dm^{-3} respektiewelik. Die volume van hierdie oplossing is 250. cm^3.
125 cm^3 van 'n 0.127 mol.dm^{-3} koper(II)sulfaat-oplossing word by die eersgenoemde oplossing gevoeg en goed gemeng.
Wenk: oorweeg die moontlikheid van 'n neerslag.

1.1 A solution consists of ammonium sulphide and ammonium sulphate, with concentrations 0.100 mol.dm^{-3} and 0.200 mol.dm^{-3} respectively. The volume of this solution is 250. cm^3.
125 cm^3 of a 0.127 mol.dm^{-3} copper(II) sulphate solution was added to the first solution and mixed well.
Hint: consider the possibility of a precipitate.

1.1.1 Bereken die sulfiedioonkonsentrasie in die finale oplossing. [7]

1.1.1 Calculate the sulphide ion concentration in the final solution. [7]

add → 125 cm^3, $[CuSO_4] = 0.127$ mol/dm^3

$[(NH_4)_2S] = 0.100$ mol/dm^3
$[(NH_4)_2SO_4] = 0.200$ mol/dm^3
250. cm^3

NH_4^+, S^{2-} and SO_4^{2-} are in solution. This is the only prec. reaction possible

Precipitation reaction:

$Cu^{2+}_{(aq)} + S^{2-}_{(aq)} \rightarrow CuS_{(s)}$

ratio is 1:1 ⇒ easy!

$n(Cu^{2+})$ added $= 0.125 \times 0.127 = 0.0159$ moles

$n(S^{2-})$ in solution $= 0.100 \times 0.250 = 0.0250$ moles

$\Rightarrow S^{2-}_{(aq)}$ left in solution $= (0.0250 - 0.0159) = 9.13 \times 10^{-3}$ mol

$\Rightarrow [S^{2-}] = \frac{9.1 \times 10^{-3} \text{ mol}}{0.375 \text{ dm}^3} = 2.43 \times 10^{-2}$ mol/dm^3

now the total volume

1.1.2 Bereken die ammoniumioon-konsentrasie in die finale oplossing. [3]

1.1.2 Calculate the ammonium ion concentration in the final solution. [3]

From $(NH_4)_2S$: $n(NH_4^+) = 0.100 \times 0.250 \times 2$
$= 5.00 \times 10^{-2}$ mol

From $(NH_4)_2SO_4$: $n(NH_4^+) = 0.200 \times 0.250 \times 2$
$= 1.00 \times 10^{-1}$ mol

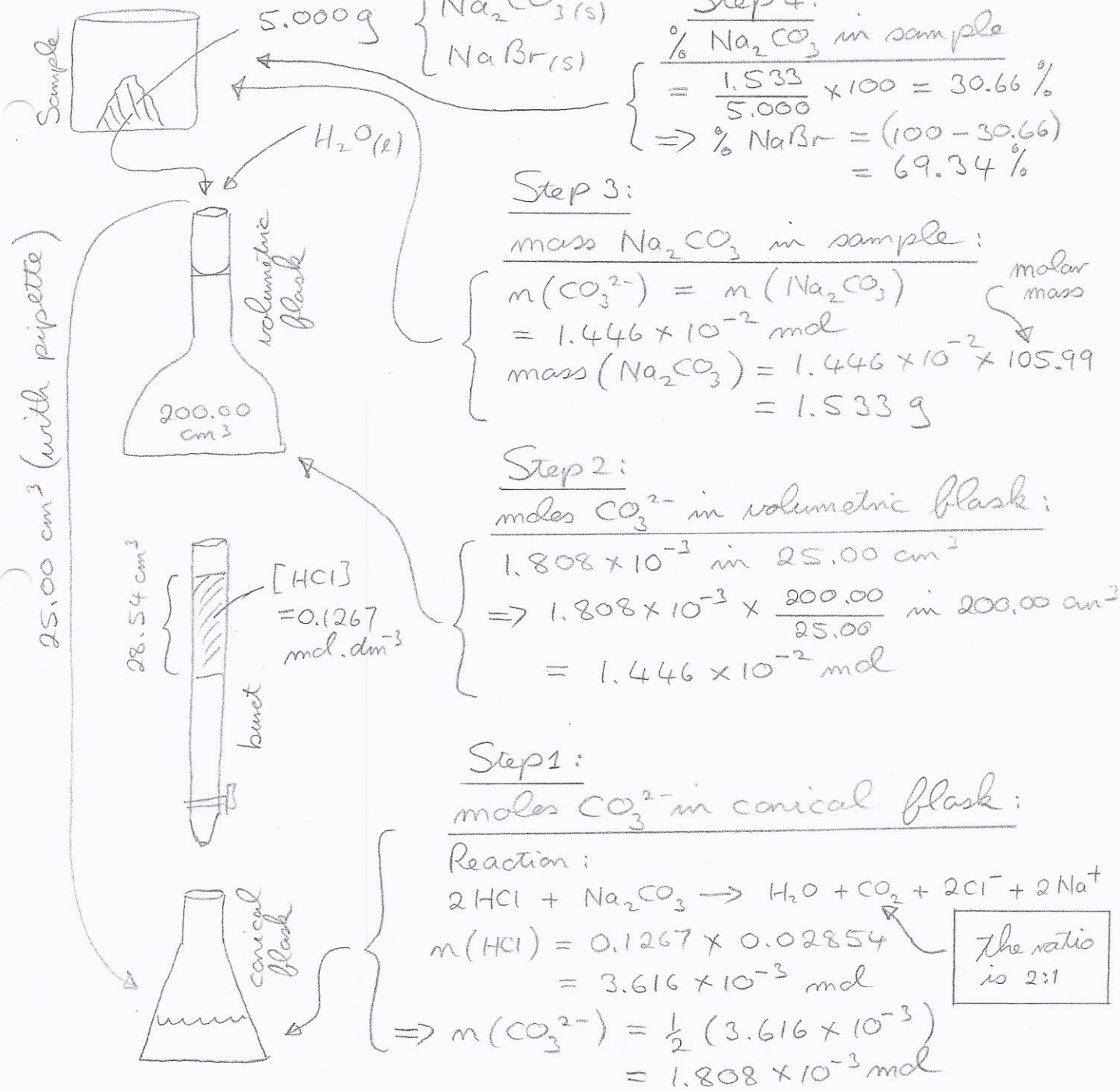
$\Rightarrow n(NH_4^+)_{total} = (5.00 \times 10^{-2} + 1.00 \times 10^{-1})$
$= 1.50 \times 10^{-1}$ mol

$\Rightarrow [NH_4^+] = \frac{1.50 \times 10^{-1}}{0.375} = 4.00 \times 10^{-1}$ mol/dm^3
(or 0.400 mol/dm^3)

1.2 'n Vaste stof-mengsel bestaan uit natriumkarbonaat en natriumbromied.
5.000 g van hierdie mengsel word afgeweeg en in 'n 200.00 cm^3 volumetriese fles geplaas, opgelos in gedistilleerde water en opgemaak tot by die ykmerk. Die oplossing was daarna deeglik gemeng.
25.00 cm^3 van hierdie oplossing word in 'n koniese fles gepipetteer en getitreer met 'n 0.1267 $mol.dm^{-3}$ soutsuuroplossing. Die titrasiesyfer is 28.54 cm^3.
Bepaal die persentasie natriumbromied in die oorspronklike vaste stof-mengsel. **[10]**

1.2 A solid mixture consists of sodium carbonate and sodium bromide.
5.000 g of this mixture was weighed out, transferred into a 200.00 cm^3 volumetric flask, dissolved in distilled water and made up to the graduation mark. The solution was then thoroughly mixed.
25.00 cm^3 of this solution was pipetted into a conical flask and titrated with a 0.1267 $mol.dm^{-3}$ hydrochloric acid solution. The titration value was 28.54 cm^3.
Determine the percentage sodium bromide in the original solid mixture. **[10]**

Note: Read this memo from the bottom



Step 4:

% Na_2CO_3 in sample

$= \frac{1.533}{5.000} \times 100 = 30.66\ \%$

$\Rightarrow$ % NaBr $= (100 - 30.66)$

$= 69.34\ \%$

Step 3:

mass Na_2CO_3 in sample:

$n(CO_3^{2-}) = n(Na_2CO_3)$

$= 1.446 \times 10^{-2}$ mol

mass (Na_2CO_3) $= 1.446 \times 10^{-2} \times 105.99$ (molar mass)

$= 1.533$ g

Step 2:

moles CO_3^{2-} in volumetric flask:

1.808×10^{-3} in 25.00 cm^3

$\Rightarrow 1.808 \times 10^{-3} \times \frac{200.00}{25.00}$ in 200.00 cm^3

$= 1.446 \times 10^{-2}$ mol

Step 1:

moles CO_3^{2-} in conical flask:

Reaction:

$2HCl + Na_2CO_3 \rightarrow H_2O + CO_2 + 2Cl^- + 2Na^+$

$n(HCl) = 0.1267 \times 0.02854$

$= 3.616 \times 10^{-3}$ mol

The ratio is 2:1

$\Rightarrow n(CO_3^{2-}) = \frac{1}{2}(3.616 \times 10^{-3})$

$= 1.808 \times 10^{-3}$ mol

Vraag 2 Stoigiometrie en Redoksreaksies [20]	Question 2 Stoichiometry and Redox Reactions [20]

[4] [5]

2.1 Hidrasien reageer as volg met distikstoftetroksied:
$N_2H_4(\ell) + N_2O_4(g) \rightarrow N_2(g) + H_2O(g)$
Dit is bekend dat die persentasie-opbrengs van stikstofgas slegs 86.0% is.

2.1.1 125 g stikstofgas moet berei word.
150. g $N_2H_4(\ell)$ is beskikbaar.
Bereken watter massa $N_2O_4(g)$ moet met die 150. g $N_2H_4(\ell)$ gemeng word om gevraagde hoeveelheid stikstofgas te lewer. [7]

2.1 Hydrazine reacts as follows with dinitrogen tetroxide:
$N_2H_4(\ell) + N_2O_4(g) \rightarrow N_2(g) + H_2O(g)$
It is known that the percent yield of nitrogen gas is only 86.0%.

2.1.1 125 g of nitrogen gas is to be prepared.
150. g of $N_2H_4(\ell)$ is available.
Calculate what mass of $N_2O_4(g)$ should be mixed with the 150. g of $N_2H_4(\ell)$ to yield the required quantity of nitrogen gas. [7]

$2\,N_2H_4 + N_2O_4 \longrightarrow 3N_2 + 4\,H_2O$

86.0% of $x = 125$

We want : 125 g N_2

$\Rightarrow$ Plan for more: $\frac{125}{x} \times 100 = 86.0$

$x = 145$ g N_2

$\Rightarrow n(N_2) = \frac{145}{28.02} = 5.19$ mol

$\Rightarrow$ We need: $\frac{1}{3}(5.19)$ mol N_2O_4

$= 1.73$ mol N_2O_4

$\Rightarrow$ mass $(N_2O_4) = 1.73 \times 92.02$

$= 159$ g

2.1.2 Bereken watter massa van watter reagens bly oor nadat 125 g stikstofgas gevorm het. [3]

2.1.2 Calculate what mass of which reactant remains after 125 g of nitrogen gas was formed. [3]

N_2H_4 bly oor.

N_2H_4 gereageer $= \frac{2}{3}(5.19)$ mol $= 3.46$ mol

massa (N_2H_4) gereageer $= 3.46 \times 32.06 = 111$ g

massa oor $= (150. - 111)$ g $= 39$ g

2.2 Die volgende redoksreaksie vind plaas in 'n swaelsuurmedium. Balanseer die reaksievergelyking.
Gee die halfreaksies, oksidasiegetalle en alle stappe, insluitend die netto ioniese en netto molekulêre gebalanseerde reaksievergelykings:
$KMnO_4 + KI \rightarrow MnSO_4 + I_2$ **[10]**

2.2 The following redox reaction takes place in a sulphuric acid medium. Balance the reaction equation.
Give half reactions, oxidation numbers and all steps, including the net ionic and net molecular balanced equations:
$KMnO_4 + KI \rightarrow MnSO_4 + I_2$ **[10]**

+8 −1 +2 0

$MnO_4^- + I^- \rightarrow Mn^{2+} + I_2$

red

ox

Spectators:
K^+ and SO_4^{2-}. Put them back in the last step.

oxidation: $2\,I^- \rightarrow I_2 + 2e^-$

(×5) $10\,I^- \rightarrow 5\,I_2 + 10e^-$

reduction: $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

(×2) $2MnO_4^- + 16H^+ + 10e^- \rightarrow 2Mn^{2+} + 8H_2O$

net ionic: $2MnO_4^- + 16H^+ + 10\,I^- \rightarrow 5\,I_2 + 2Mn^{2+} + 8H_2O$

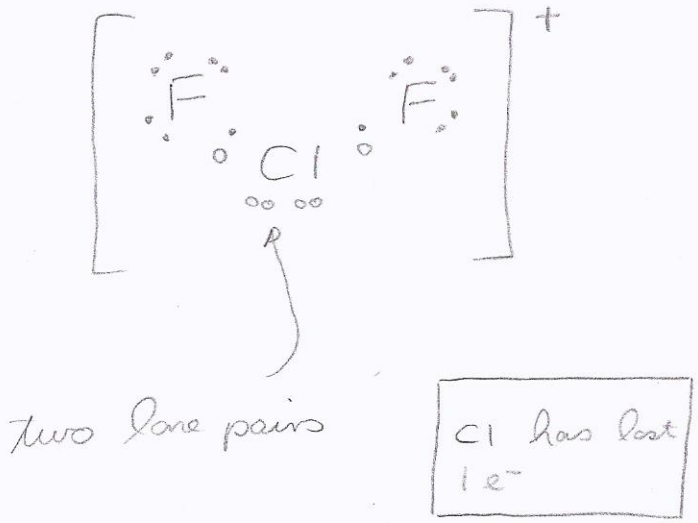
net molecular:

$2KMnO_4 + 8H_2SO_4 + 10\,KI \rightarrow 5\,I_2 + 2MnSO_4 + 8H_2O + 6K_2SO_4$

Vraag 3 Chemiese Binding en Molekulêre Struktuur [20]	Question 3 Chemical Bonding and Molecular Structure [20]
3.1 Teken die Lewisstrukture van die volgende twee ione. Stel die elektrone voor met simbole (bv. punte of kruisies). Moet nie strepies gebruik om bindings voor te stel nie. Alle alleenpaar elektrone moet ingeteken word. Voltooi daarna die res van die tabel.	3.1 Draw the Lewis Structures of the following two ions. Represent electrons with symbols (e.g. dots or crosses). Do not use dashes to represent bonds. All lone electron pairs must be drawn in. Then complete the rest of the table.

[8]

3.1.1 ClF_2^+

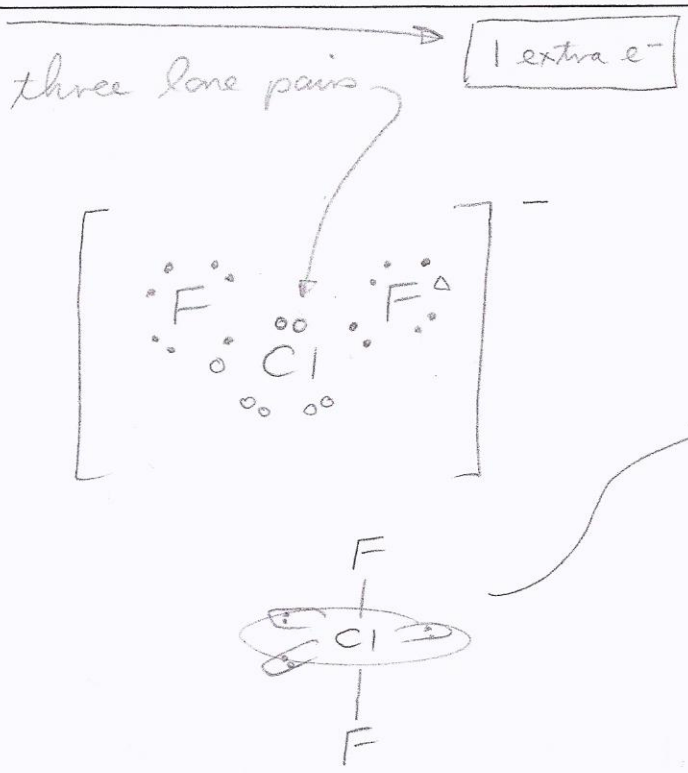


Electron domain geometry/ Elektrondomein-geometrie: tetrahedral

Molecular geometry / Molekulêre geometrie: bent / gebuig

Approximate size of the bonding angle / Benaderde grootte van die bindingshoek: ~ 109°

3.1.2 ClF_2^-



Electron domain geometry/ Elektrondomein-geometrie: Trigonal bipyramidal

Molecular geometry / Molekulêre geometrie: linear

Approximate size of the bonding angle / Benaderde grootte van die bindingshoek: 180°

[12]

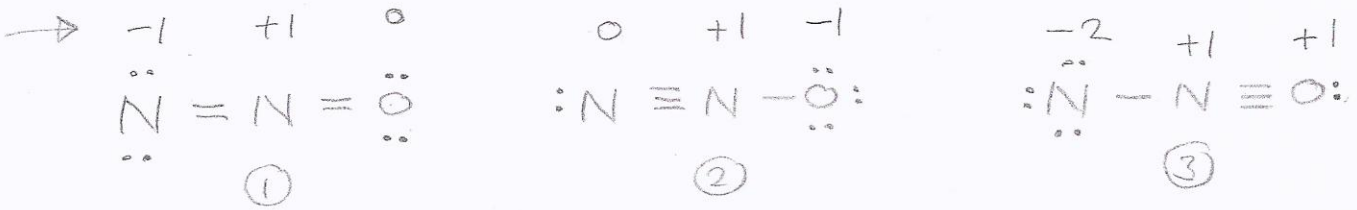
3.2 Teken al die resonansstrukture van die stikstof(I)oksied-molekule, N_2O.
Gebruik strepies om bindingspare voor te stel, maar teken alle alleenpaar elektrone in.
Ken ook die formele lading van elke atoom in al u strukture toe en skryf dit duidelik in op die Lewisstrukture bo-aan elke atoom.
Besluit dan watter resonansstruktuur die kleinste bydrae lewer. **[8]**

[8]

3.2 Draw all the resonance structures of the nitrogen(I) oxide molecule, N_2O.
Use dashes to represent bonding pairs, but draw in all lone pair electrons.
Assign the formal charge of each atom in all of your structures and clearly write them on your Lewis Structures above each atom.
Then decide which Resonance structure will have the smallest contribution. **[8]**

N_2O : N N O

the least electronegative atom in the middle
⇒ O is not in the middle.



formal charges

Because O is highly electronegative it will never assume a positive formal charge.
⇒ structure ③ will have the smallest contribution

CMY 117
Semester Test 2
20 April 2009
Section B: Multiple Choice Questions

Test

Question	Answer	Marks
2	G	2
3	C	2
4	C	2
5	B	2
6	B	2
7	I	2
8	E	2
9	C	2
10	B	2
11	H	2
12	G	3
13	E	3
14	A	2
15	C	3
16	A	3
17	D	2
18	F	3
19	C	3
20	A	2
21	A	2
22	F	2
23	C	2
24	G	2
25	D	3
26	B	2
27	E	3
		60

Practicals

Question	Answer	Marks
1	B	2
2	D	2
3	A	2
4	E	2
5	B	2
6	A	2
7	E	2
8	E	2
9	B	2
10	E	2
		20