DEPARTEMENT CHEMIE
DEPARTMENT OF CHEMISTRY

100 1908 - 2008

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CMY 117

SEMESTERTOETS 3 / SEMESTER TEST 3

AFDELING A / SECTION A

DATUM / DATE: 11 Mei 2009 / 11 May 2009
TYD / TIME: 2½ uur / hours
PUNTE / MARKS: 100

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

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VAN EN VOORLETTERS SURNAME AND INITIALS	Memorandum		
REGISTRASIENOMMER REGISTRATION NUMBER		**GRAADKURSUS DEGREE COURSE**	
HANDTEKENING SIGNATURE			

VRAAG QUESTION	PUNTE MARKS		EKSAMINATOR EXAMINER
1		18	
2		17	
3		15	
TOTAAL: AFDELING A TOTAL: SECTION A		50	
TOTAAL: AFDELING B TOTAL: SECTION B		50	
TOTAAL / TOTAL		100	

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
Chemiese Binding en Struktuur [18]

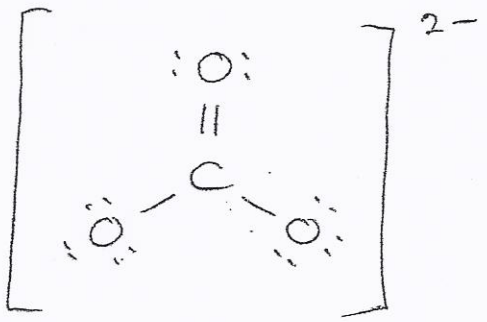
Question 1
Chemical Bonding and Structure [18]

[8]

Teken die Lewisstrukture van die volgende. Gebruik punte kruisies of strepies. Alle alleenpaar elektrone moet ingeteken word. In gevalle waar resonansstrukture moontlik is, teken slegs een struktuur.
Voltooi daarna die res van die tabel.

Draw the Lewis Structures of the following. Use dots, crosses or dashes. All lone electron pairs must be drawn in. In cases where resonance structures are possible, draw only one structure.
Then complete the rest of the table.

1.1 CO_3^{2-}



Electron domain geometry/ Elektrondomein-geometrie:	trigonal planar
Molecular geometry / Molekulêre geometrie:	trigonal planar
Approximate size of the bonding angles / Benaderde grootte van die bindingshoeke:	120°

1.2 O_3

Electron domain geometry/ Elektrondomein-geometrie:	trigonal planar
Molecular geometry / Molekulêre geometrie:	bent gebuig
Approximate size of the bonding angle / Benaderde grootte van die bindingshoek:	120°

[12]

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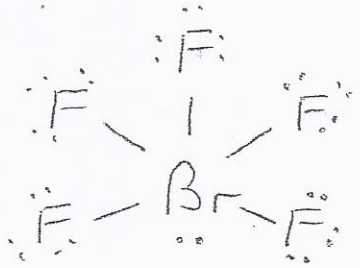


	Electron domain geometry/ Elektrondomein-geometrie: octahedral
	Molecular geometry / Molekulêre geometrie: square pyramidal
	Approximate size of the bonding angles / Benaderde grootte van die bindingshoeke: 90°, 180°

vraag 2
Chemiese Ewewig [17]

2.1 Beskou die volgende ewewig:

$CO_2(g) + H_2(g) \rightleftharpoons CO(g) + H_2O(g)$

4.5 mol koolstofdioksiedgas en 4.0 mol waterstofgas word in 'n 5.00 dm^3 fles geplaas by 750°C.
By ewewig word gevind dat die konsentrasie van die waterdamp 0.52 $mol.dm^{-3}$ is.
Bereken hieruit die waarde van K_c van hierdie ewewig by 750°C. [7]

Question 2
Chemical Equilibrium [17]

2.1 Consider the following equilibrium:

$CO_2(g) + H_2(g) \rightleftharpoons CO(g) + H_2O(g)$

4.5 moles of carbon dioxide gas and 4.0 moles of hydrogen gas were placed in a 5.00 dm^3 flask at 750°C.
At equilibrium it was found that the concentration of the water vapour was 0.52 $mol.dm^{-3}$.
From this, calculate the value of K_c of this equilibrium at 750°C. [7]

	CO_2	H_2	CO	H_2O
Initial	0.90	0.80	0	0
Change	−0.52	−0.52	+0.52	+0.52
Equilibr	0.38	0.28	0.52	0.52

$$K_c = \frac{[CO][H_2O]}{[CO_2][H_2]}$$

$$= \frac{(0.52)(0.52)}{(0.38)(0.28)}$$

$$= 2.5$$

2.2 Die volgende ewewig bestaan by 2000°C:

$2NO(g) \rightleftharpoons N_2(g) + O_2(g)$ $K_c = 49$

Op 'n sekere stadium is die konsntrasies die volgende:

$[NO(g)] = 1.5 \text{ mol.dm}^{-3}$

$[N_2(g)] = 2.0 \text{ mol.dm}^{-3}$

$[O_2(g)] = 2.0 \text{ mol.dm}^{-3}$

Verduidelik hoe die sisteem sal verander, en bereken die ewewigkonsentrasies van al die chemiese spesies by 2000°C.

Wenk: Maak onder andere gebruik van Q_c. **[10]**

2.2 The following equilibrium exists at 2000°C:

$2NO(g) \rightleftharpoons N_2(g) + O_2(g)$ $K_c = 49$

At a certain moment the concentrations are the following:

$[NO(g)] = 1.5 \text{ mol.dm}^{-3}$

$[N_2(g)] = 2.0 \text{ mol.dm}^{-3}$

$[O_2(g)] = 2.0 \text{ mol.dm}^{-3}$

Explain how the system will change, and calculate the equilibrium concentrations of all the chemical species at 2000°C.

Hint: Among others, use Q_c. **[10]**

$$Q_c = \frac{[N_2][O_2]}{[NO]^2} = \frac{(2.0)(2.0)}{(1.5)^2} = 1.8 \quad (1.77\ldots)$$

$\Rightarrow Q_c < K_c$

$\Rightarrow Q_c$ will increase, up to the value of K_c.

$\Rightarrow [N_2]$ and $[O_2]$ will increase and $[NO]$ will decrease.

$\Rightarrow$ the forward reaction will be favoured.

	NO	N_2	O_2
Initial	1.5	2.0	2.0
Change	$-2x$	$+x$	$+x$
Equilibrium	$1.5-2x$	$2.0+x$	$2.0+x$

$$K_c = \frac{[N_2][O_2]}{[NO]^2} = \frac{(2.0+x)^2}{(1.5-2x)^2} = 49$$

$$\Rightarrow 7 = \frac{2.0+x}{1.5-2x} \Rightarrow x = 0.57 \quad (0.5666\ldots)$$

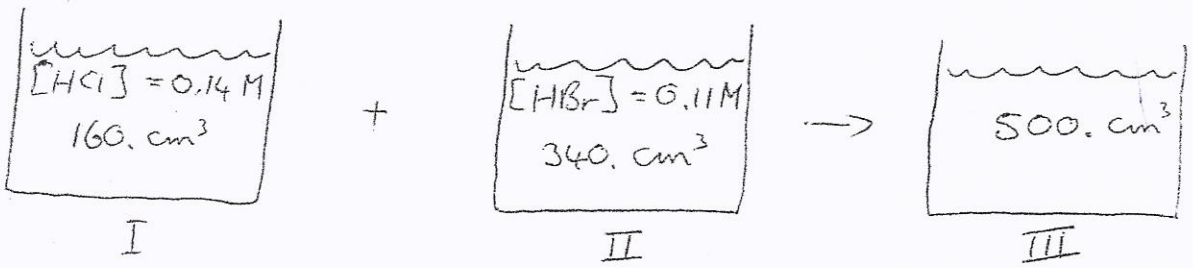
$\Rightarrow [N_2]_{eq} = [O_2]_{eq} = 2.0 + 0.57 = 2.6 \text{ mol/dm}^3$

$[NO] = 1.5 - 2(0.57) = 0.37 \text{ mol/dm}^3$

3.1 Die volgende twee oplossings word saamgevoeg en deeglik gemeng:
160. cm^3 van 0.14 $mol.dm^{-3}$ HCl,
en
340. cm^3 van 0.11 $mol.dm^{-3}$ HBr.
Bereken die pH van die finale oplossing by 25°C. [7]

3.1 The following two solutions were added together and mixed well:
160. cm^3 of 0.14 $mol.dm^{-3}$ HCl,
and
340. cm^3 of 0.11 $mol.dm^{-3}$ HBr.
Calculate the pH of the final solution at 25°C. [7]

Note: both are solutions of strong acids. Thus, they are fully dissociated.



I: $n(HCl) = 0.14 \times 0.160 = 0.022$ moles

$\Rightarrow n(H_3O^+) = 0.022$ moles

II: $n(HBr) = 0.11 \times 0.340 = 0.037$ moles

$\Rightarrow n(H_3O^+) = 0.037$ moles

III: $n(H_3O^+) = (0.022 + 0.037)$ moles

$= 0.060$ moles

Total volume now = 500. cm^3

$\Rightarrow [H_3O^+] = \frac{0.060}{0.500} = 0.12\ mol.dm^{-3}$

$pH = -\log [H_3O^+]$

$= -\log (0.12)$

$= 0.92$

3.2 Bereken die pH van 'n 2.55 mol.dm^{-3} waterstoffluoriedsuur-oplossing (HF) by 25°C. Gee al die stappe en verduidelik kortliks die aanname wat u maak om die berekening te vereenvoudig. **Wenk:** Gebruik inligting van die inligtingsblad. **[8]**

3.2 Calculate the pH of a 2.55 mol.dm^{-3} solution of hydrofluoric acid (HF) at 25°C. Give all the steps and briefly explain the assumption you make to simplify the calculation. **Hint:** Use information from the datasheet. **[8]**

HF is a weak acid, with

$K_a = 6.8 \times 10^{-4}$ at 25°C.

$$HF + H_2O \rightleftharpoons F^- + H_3O^+$$

$$K_a = 6.8 \times 10^{-4} = \frac{[F^-][H_3O^+]}{[HF]}$$

	HF	H_3O^+	F^-
Initial	2.55	0	0
Change	$-x$	$+x$	$+x$
Equilibr.	$2.55-x$	x	x

$$\Rightarrow 6.8 \times 10^{-4} = \frac{x^2}{2.55-x}$$

It can be assumed that x is much smaller than 2.55, because HF is a weak acid.

$$\Rightarrow 6.8 \times 10^{-4} = \frac{x^2}{2.55}$$

$$\Rightarrow x = 0.042$$

$$\Rightarrow [H_3O^+]_{eq} = 0.042 \text{ mol.dm}^{-3}$$

$$pH = -\log [H_3O^+]$$
$$= -\log (0.042) = 1.38$$

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11-May-09

Section B: Multiple Choice Questions
Memorandum

Question	Answer	Marks
2	D	2
3	B	2
4	D	2
5	B	2
6	C	2
7	C	2
8	E	2
9	B	2
10	C	2
11	A	2
12	B	2
13	C	2
14	B	2
15	C	2
16	C	2
17	C	2
18	C	2
19	D	2
20	A	2
21	B	2
22	C	2
23	~~C~~ D	2
24	C	3
25	B	3
		50