



Benodighede vir hierdie vraestel/Requirements for this paper:

Antwoordskrifte/ Answer scripts:	<input type="checkbox"/>	Multikeusekaarte (A5)/ Multi-choice cards (A5):	<input type="checkbox"/>
Presensiestrokies (Invulvraestel)/ Attendance slips (Fill-in paper):	<input checked="" type="checkbox"/>	Multikeusekaarte (A4)/ Multi-choice cards (A4):	<input type="checkbox"/>
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Sakrekenaars/Calculators: Ja/Yes

Ander hulpmiddels/Other resources:

'n Nie-programmeerbare sakrekenaar.
A non programmable calculator.

Tipe Assessering/
Type of Assessment:

Eksamen 1e geleentheid
Exam 1st opportunity
Vraestel/Paper 1

Kwalifikasie/
Qualification: **B.Sc./B.Pharm./
B.Ing.**

Modulekode/
Module code:

CHEM111

Tydspanne/
Duration: **3 uur**
3 hour

Module beskrywing/
Module description:

Inleidende Anorganiese en Fisiese Chemie

Maks/
Max: **111**

Eksaminator(e)/
Examiner(s):

Dr C.E. Read

Datum/
Date: **22/06/2017**

Mev M.H. du Toit

Tyd/
Time: **09:00**

Moderator(s):

Dr C.G.C.E. van Sittert

Inhandiging van antwoordskrifte/Submission of answer scripts: **Gewoon/Ordinary**

Titel:
Title:

Van:
Surname:

Volle voorletters:
Full initials:

Universiteitsnommer:
University number:

Eksamenvoorskrifte / Examination instructions

1. Studente mag in die eerste halfuur van 'n sessie tot die lokaal toegelaat word, maar geen ekstra tyd word toegestaan nie.
2. Geen student word toegelaat om die lokaal te verlaat binne die eerste halfuur van 'n eksamensessie nie.
3. Studente bring sakke na lokaal op **eie risiko**, en moet dit voor in die lokaal neersit.
4. Studente mag nie selfone/elektroniese toestelle by hulle hê en/of hanteer nie.
5. Geen verversings word in 'n eksamenlokaal toegelaat nie.
6. Studente mag nie die lokaal verlaat om te gaan rook nie.
7. Skryf op beide kante van die bladsye.
8. Skryf slegs in swart of blou ink.
9. Geen bladsye mag uit die antwoordskrif verwyder word nie.
10. Studente mag nie ontoelaatbare materiaal by hulle hê tydens 'n sessie nie, bv. notas en/of objekte wat notas bevat nie.
11. Geen items mag tydens die sessie geleen word nie.
12. Studente mag nie 'n ander student probeer help of probeer om hulp te kry nie.
13. Studente **moet** hul antwoordskrifte aan toesighouers oorhandig voordat hulle die lokaal verlaat.
14. Die presensiestrokies op die agterblad, wat ook as onderneming geld, **moet** voltooi en ingegee word.
1. Students are allowed into the venue in the first half hour of a session, but no extra time is granted.
2. No student is allowed to leave the venue before half an hour of the examination session has elapsed.
3. Students bring bags to the venue at **own risk**, and must put them in front of the room.
4. Students may not have cell phones/electronic devices with them and/or handle them.
5. No refreshments are allowed in the examination venue.
6. Students may not leave the room for a smoke break.
7. Write on both sides of each page.
8. Write in black or blue ink only.
9. No pages may be removed from the answer scripts.
10. Students may not have unauthorized material with them during a session, e.g. notes and/or objects that contain notes.
11. No items may be borrowed during the session.
12. Students may not attempt to assist another student, or attempt to obtain assistance.
13. Students **must** hand in their answer scripts to invigilators before they leave the venue.
14. The attendance slip on the back cover that also serves as an undertaking, **must** be completed and handed in.

LEES DIE VOLGENDE INSTRUKSIES DEEGLIK

Antwoorde op vrae moet in die oopgelate ruimtes by elke vraag gegee word.

Die rugkante van bladsye kan ook gebruik word maar dan moet dit duidelik by die vraag aangedui word. Dit kan ook vir rofwerk gebruik word.

Die vraestel moet in pen voltooi word.

Die volgende tabelle is aangeheg: **(Jy mag bladsye 18 tot 23 afskeur vir gebruik. Moet dit nie inhandig saam met jou antwoordstel nie.)**

- 'n Periodieke tabel
- 'n Oplosbaarheidstabel
- 'n Tabel met geselekteerde termodinamiese waardes
- 'n Tabel met K_{sp} -waardes
- 'n Tabel met suur-basis eienskappe van soute
- 'n Tabel met ionisasiekonstantes van sommige sure en hul gekonjugeerde basisse

Sakrekenaars is toelaatbaar. Die sakrekenaarfasiliteit op selfone word nie toegelaat nie.

Avogadrogetal (N_A): $6,022 \times 10^{23} \text{ mol}^{-1}$

Alle berekeninge moet getoon word!

READ THE FOLLOWING INSTRUCTIONS THOROUGHLY

Answers on questions must be given in the blank spaces below each question.

The back of pages can also be used, but it should then be indicated at each question. It can also be used for own scribbling.

The paper must be completed in pen.

The following tables are attached: (You may tear off pages 18 to 23 for use. Do not hand it in with your answer sheets.)

- *A periodic table*
- *A solubility table*
- *A table with selected thermodynamic values*
- *A table of K_{sp} values*
- *A table with acid-base properties of salts*
- *A table with ionization constants of some acids and its conjugated bases*

Calculators are allowed. The calculator facility on mobile phones is not allowed.

Avogadro's number (N_A): $6,022 \times 10^{23} \text{ mol}^{-1}$

All calculations must be shown!

Vraag 1. / Question 1.**[10 PUNTE. / 10 MARKS.]****ATOME, IONE EN MOLEKULES. / ATOMS, IONS AND MOLECULES.**

- 1.1 Toon die aantal protone, neutron en elektrone in die volgende verbindings of ione aan. / *Indicate the number of protons, neutrons and electrons in the following compounds or ions.* **[5]**

Chemiese stof. <i>Chemical substance.</i>	Protone. / <i>Protons.</i>	Neutrone. / <i>Neutrons.</i>	Elektrone. / <i>Electrons.</i>
Ba ²⁺			
N ³⁻			
Co ³⁺			
Te ²⁻			
²³⁵ U			

- 1.2 Wat is die formules van die verbindings wat ooreenstem met die gegewe name in die tabel. / *What are the formulas of the compounds that correspond to the names given in the following table:* **[5]**

Naam van verbinding. / <i>Compound name.</i>	Formule. / <i>Formula.</i>
Koolstoftetrabromied. / <i>Carbon tetrabromide.</i>	
Kobalt(II)fosfaat. / <i>Cobalt(II) phosphate.</i>	
Magnesiumchloried. / <i>Magnesium chloride.</i>	
Nikkel(II)asetaat. / <i>Nickel(II) acetate.</i>	
Kalsiumnitriet. / <i>Calcium nitrite.</i>	

Vraag 2. / Question 2.

[10 PUNTE. / 10 MARKS.]

CHEMIESE REAKSIES. / CHEMICAL REACTIONS.

- 2.1 (i) Voorspel die produkte vir die volgende reaksie en dui aan in watter toestand (aq, s, ℓ, g) dit voorkom.
 (ii) Balanseer hierdie vergelyking, en (iii) gee ook die netto ioniese vergelyking. / (i) Predict the product for the following reaction and show in what state (aq, s, ℓ, g) they occur. (ii) Balance the equation, and (iii) give the net ionic equation. [3]

Reagense. / Reagents.		Produkte. / Products.
___ Pb(NO ₃) ₂ (aq) + ___ KBr(aq)	→	
Netto Vergelyking. / Net Equation.	→	

- 2.2 Bepaal die oksidasietoestand vir elk van die elemente in die volgende verbinding. Slegs die eenvoudigste heelgetalle sal aanvaar word. / Determine the oxidation state for each of the elements in the following compound. Only the simplest integers will be accepted. [3]

Verbinding. / Compound.	Oksidasietoestand. / Oxidation State.		
	Cu	Mn	O
Cu ₂ MnO ₄			

- 2.3 Klassifiseer die volgende reaksies as of oksidasie-reduksie of presipitasie of suur-basis reaksies. Classify the following reactions as either oxidation-reduction or precipitation or acid-base reactions. [4]

Reaksie. / Reaction.	Klassifikasie. / Classification.
Ca(s) + 2H ₂ O(ℓ) → Ca(OH) ₂ (s) + H ₂ (g)	
Zn(OH) ₂ (s) + H ₂ SO ₄ (aq) → ZnSO ₄ (aq) + 2H ₂ O(ℓ)	
CdCl ₂ (aq) + Na ₂ S(aq) → CdS(s) + 2NaCl(aq)	
C ₂ H ₄ (g) + 3O ₂ (g) → 2CO ₂ (g) + 2H ₂ O(g)	

STOIGIOMETRIE. / STOICHIOMETRY.

Oorweeg om koper(II)sulfaat met yster te reageer. Twee moontlike reaksies, voorgestel deur die volgende reaksies, kan plaasvind. / Consider reacting copper(II) sulfate with iron. Two possible reactions can occur, as represented by the following equations:

- (1) $\text{Koper(II)sulfaat(aq)} + \text{yster(s)} \rightarrow \text{koper(s)} + \text{yster(II)sulfaat(aq)}$
 $\text{copper(II) sulfate(aq)} + \text{iron(s)} \rightarrow \text{copper (s)} + \text{iron(II) sulfate(aq)}$
- (2) $\text{Koper(II)sulfaat(aq)} + \text{yster(s)} \rightarrow \text{koper(s)} + \text{yster(III)sulfaat(aq)}$
 $\text{copper(II) sulfate(aq)} + \text{iron(s)} \rightarrow \text{copper (s)} + \text{iron(III) sulfate(aq)}$

Jy plaas 87.7 mL van 'n 0.500 M oplossing van koper(II)sulfaat in 'n beker. Dan gooi jy 2.00 g yster vylsels by die koper(II)sulfaat-oplossing. Nadat die reaksie plaasgevind het, isoleer jy 2.27 g koper. Watter een van die twee vergelykings hierbo beskryf die reaksie wat plaasgevind het? Staaf you antwoord met berekeninge.

You place 87.7 mL of a 0.500 M solution of copper(II) sulfate in a beaker. You then add 2.00 g of iron filings to the copper(II) sulfate solution. After the reaction occurs, you isolate 2.27 g of copper. Which equation above describes the reaction that occurred? Support your answer with calculations. [12]

Daar is nog spasie op die volgende bladsy vir berekeninge.

There is more space on the next page for calculations.

ENERGIEOORDRAG (TERMODINAMIKA). / ENERGY TRANSFER (THERMODINAMICS).

- 4.1 'n Monster van nikkell word verhit tot 99.8°C en geplaas in 'n koffiekoppie kalorimeter wat 150.0 g water bevat by 23.5°C . Nadat die metaal afgekoel het, is die finale temperatuur van die metaal en water mengsel 25.0°C . As die spesifieke hittekapasiteit van nikkell $0.444 \text{ J/g}^{\circ}\text{C}$ is, watter massa nikkell is oorspronklik verhit? Die spesifieke hittekapasiteit van water is $4.18 \text{ J/g}^{\circ}\text{C}$. Veronderstel dat geen hitte verloor word na die omgewing nie. / *A sample of nickel is heated to 99.8°C and placed in a coffee cup calorimeter containing 150.0 g water at 23.5°C . After the metal cools, the final temperature of the metal and water mixture is 25.0°C . If the specific heat capacity of nickel is $0.444 \text{ J/g}^{\circ}\text{C}$, what mass of nickel was originally heated? The specific heat capacity of water is $4.18 \text{ J/g}^{\circ}\text{C}$. Assume no heat loss to the surroundings.* [3]

- 4.2 Die vriespunt van kwik is -38.8°C . Hoeveel energie, in joules, word vrygestel aan die omgewing as 5.00 mL kwik afgekoel word vanaf 20°C tot -38.8°C en dan gevries word tot 'n vastestof. (Die digtheid van die kwik vloeistof is 13.6 g/cm^3 . Die spesifieke hittekapasiteit is $0.140 \text{ J/g}^{\circ}\text{C}$ en die hitte van fusie is 11.4 J/g .) / *The freezing point of mercury is -38.8°C . What quantity of energy, in joules, is released to the surroundings if 5.00 mL of mercury is cooled from 20°C to -38.8°C and then frozen to a solid? (The density of the liquid mercury is 13.6 g/cm^3 . Its specific heat capacity is $0.140 \text{ J/g}^{\circ}\text{C}$ and its heat of fusion is 11.4 J/g .)* [3]

4.3 Definieer die term spesifieke hittekapasiteit. / Define the term specific heat capacity.

[2]

Vraag 5. / Question 5.

[20 PUNTE. / 20 MARKS.]

CHEMIESE EWEWIG. / CHEMICAL EQUILIBRIUM.

5.1 Die volgende ewewigskonsentrasies by 127^oC word waargeneem vir die Haber-proses: / The following equilibrium concentrations were observed for the Haber process at 127^oC: [6]

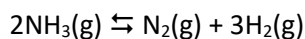
$$[\text{NH}_3] = 3.1 \times 10^{-2} \text{ mol/L}$$

$$[\text{N}_2] = 8.5 \times 10^{-1} \text{ mol/L}$$

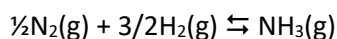
$$[\text{H}_2] = 3.1 \times 10^{-3} \text{ mol/L}$$

5.1.1 Bereken die waarde van K_1 by 127^oC vir die reaksie van die Haberproses. / Calculate the value of K_1 at 127^oC for the reaction of the Haber process.

5.1.2 Bereken die waarde van die ewewigkonstante, K_2 , by 127^oC vir die volgende reaksie. Calculate the value of the equilibrium constant, K_2 , at 127^oC for the following reaction:



5.1.3 Bereken die waarde van die ewewigkonstante, K_3 , by 127^oC vir die reaksie wat gegee word deur die vergelyking: / Calculate the value of the equilibrium constant, K_3 , at 127^oC for the reaction given by the equation:

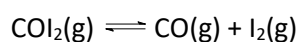


- 5.2 Gasagtige NOCl ontbind om die gasse NO en Cl₂ te vorm. By 35°C is die ewewigskonstante 1.6 x 10⁻⁵ mol. Wat is die ewewigskonsentrasies wanneer 1.0 mol NOCl in 'n 2.0 liter fles geplaas word?
Gaseous NOCl decomposes to form the gases NO and Cl₂. At 35°C the equilibrium constant is 1.6 x 10⁻⁵ mol/L. When 1.0 mol NOCl is placed in a 2.0 liter flask, what are the equilibrium concentrations? [6]

- 5.3 Wat is die verskil tussen die ewewigskonstante en die reaksiekwosient? / *What is the difference between the equilibrium constant and the reaction quotient?* [2]

- 5.4 Hoekom word gesê dat chemiese ewewigte in 'n dinamiese toestand is? / *Why are chemical equilibria said to be in a dynamic state?* [1]
- a. omrede die reagens konsentrasie stadig oor tyd afneem. / *because the reactant concentration decreases slowly over time.*
 - b. omrede die omgekeerde reaksie enige tyd dominant kan word. / *because the reverse reaction could become dominant at any moment.*
 - c. omrede die konsentrasies van al die chemiese spesies nie verander nie. / *because the concentrations of all chemical species do not change.*
 - d. omrede die voorwaartse en terugwaartse reaksies teen dieselfde tempo aanhou. / *because the forward and reverse reactions continue to occur at equal rates.*

- 5.5 0.55 M COI₂ word aanvanklik in 'n 2.00 L fles verhit en die reaksie word toegelaat om ewewig te bereik. By ewewig is die konsentrasie I₂ gelyk aan 0.022 M. Bereken die ewewigskonstante, K_c, vir die reaksie. *0.55 M of COI₂ is heated initially in a 2.00 L flask and the reaction is left to reach equilibrium. At equilibrium the concentration of I₂ is equal to 0.022 M. Calculate the equilibrium constant, K_c, for the reaction.* [5]



SURE EN BASISSE. / ACIDS AND BASES.

- 6.1 Bereken die persentasie piridien (C_5H_5N) wat die piridinium ion, $C_5H_5NH^+$, vorm in 'n 0.10 M waterige piridien oplossing ($K_b = 1.7 \times 10^{-9}$). Wat is die pH van die oplossing? / Calculate the percentage of pyridine (C_5H_5N) that forms pyridinium ion, $C_5H_5NH^+$, in a 0.10 M aqueous solution of pyridine ($K_b = 1.7 \times 10^{-9}$). What is the pH of the solution? [6]

6.2 Is oplossings van die volgende soute suur, basies of neutraal? Voltooi die volgende tabel en dui onder pH slegs aan of die pH < 7, pH > 7 of pH = 7 sal wees. Geen berekeninge is nodig nie.

Are solutions of the following salts acidic, basic, or neutral? Complete the following table and indicate under pH whether the pH will be pH < 7, pH > 7 or pH = 7. No calculations are necessary. [5]

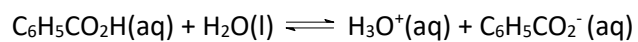
Sout / Salt	Sout reaksie in water / Salt reaction in water	K	pH
Sr(NO ₃) ₂		K _a = very small (< 10 ⁻¹⁴) K _b = very small (< 10 ⁻¹⁴)	
C ₂ H ₅ NH ₃ CN	C ₂ H ₅ NH ₃ ⁺ + H ₂ O ⇌ CN ⁻ + H ₂ O ⇌	K _a = 1.78 x 10 ⁻¹¹ K _b = 2.5 x 10 ⁻⁵	
C ₅ H ₅ NHF	C ₅ H ₅ NH ⁺ + H ₂ O ⇌ F ⁻ + H ₂ O ⇌	K _a = 5.88 x 10 ⁻⁶ K _b = 1.4 x 10 ⁻¹¹	
NH ₄ C ₂ H ₃ O ₂	NH ₄ ⁺ + H ₂ O ⇌ CH ₃ COO ⁻ + H ₂ O ⇌	K _a = 5.6 x 10 ⁻¹⁰ K _b = 5.6 x 10 ⁻¹⁰	
NaHCO ₃	HCO ₃ ⁻ + H ₂ O ⇌	K _a = very small (< 10 ⁻¹⁴) K _a = 4.8 x 10 ⁻¹¹ K _b = 2.4 x 10 ⁻⁸	

6.3 Identifiseer die suur-basis gekonjugeerde pare in die volgende reaksie. / Identify the acid-base conjugated pairs in the following reaction. [2]



6.4 Bereken die hidroksiedioonkonsentrasie en die hidroniumioonkonsentrasie in 'n waterige 0.0012 M NaOH oplossing by 25°C. Die ionproduk van water is: K_w = 1.0 x 10⁻¹⁴. / Calculate the hydroxide ion concentration and the hydronium ion concentration in a 0.0012 M aqueous solution of NaOH at 25°C. The ion product of water is: K_w = 1.0 x 10⁻¹⁴. [2]

- 6.5 Bereken die K_a -waarde van 'n 0.035 M oplossing van bensoësuur ($C_6H_5CO_2H$) indien die pH van die oplossing gelyk aan 2.83 is. / Calculate the K_a -value of a 0.035 M solution of benzoic acid ($C_6H_5CO_2H$) if the pH of the solution is equal to 2.83. [5]



ANDER ASPEKTE VAN WATERIGE EWEWIGTE. / OTHER ASPECTS OF AQUEOUS EQUILIBRIA.

- 7.1 'n Waterige oplossing van 0.750 M HCN het 'n **pH van 4.76**. Bewys deur middel van 'n AVE tabel en berekeninge dat die pH van die oplossing **verander na 7.40** indien jy aanvanklik 0.0075 M se NaCN sou byvoeg. / *An aqueous solution of 0.750 M HCN has a **pH of 4.76**. Prove by using an ICE table and calculations that the pH of the solution **changes to 7.40** if you initially added 0.0075 M NaCN to the solution.* [6]

(Gegee: / Given: $K_a = 4.0 \times 10^{-10}$, $K_b = 2.5 \times 10^{-5}$, $K_w = 1.00 \times 10^{-14}$, $M_{\text{HCN}} = 27 \text{ g.mol}^{-1}$, $M_{\text{NaCN}} = 49 \text{ g.mol}^{-1}$)

- 7.2 Jy wil 'n 1.00 L bufferoplossing met 'n pH van 5.00 voorberei. 'n Lys van moontlike sure (en die ooreenstemmende gekonjugeerde basisse) volg: / *You want to prepare a 1.00 L of buffer solution with a pH of 5.00. A list of possible acids (and the corresponding conjugated bases) follows:*

Suur: <i>Acid.</i>	Gekonjugeerde basis. <i>Conjugated base.</i>	K_a	pK_a
HCO ₂ H	HCO ₂ ⁻	1.8×10^{-4}	
CH ₃ CH ₂ COOH	CH ₃ CH ₂ COO ⁻	1.3×10^{-5}	
H ₂ CO ₃	HCO ₃ ⁻	4.2×10^{-7}	
NH ₄ ⁺	NH ₃	5.6×10^{-10}	
HPO ₄ ²⁻	PO ₄ ³⁻	3.6×10^{-13}	

7.2.1 Dui aan watter suur en gekonjugeerde basis paar gebruik gaan word om die bufferoplossing voor te berei. / *Indicate which acid and conjugate base pair will be used to prepare the buffer solution.* [1]

7.2.2 Bereken die molverhouding tussen die suur en sy gekonjugeerde basis in vraag 7.2.1. *Calculate the mole ratio between the acid and its conjugate base in question 7.2 1.* [4]

7.3 Plaas die verbindings FeCO_3 , Ag_2CO_3 en PbCO_3 in volgorde van toenemende oplosbaarheid in water deur van die K_{sp} -waardes in Tabel 3 agter in die vraestel gebruik te maak en motiveer jou antwoord. *Rank the compounds FeCO_3 , Ag_2CO_3 and PbCO_3 according to increasing solubility in water by using the K_{sp} values in Table 3 at the back of the paper and motivate your answer.* [3]

Minste oplosbaar.
Least soluble.

Meeste oplosbaar.
Most soluble.

- 7.4 Bereken die K_{sp} waarde vir bismutsulfied (Bi_2S_3), wat 'n oplosbaarheid van 1.0×10^{-15} mol/L by 25°C het.
Calculate the K_{sp} value for bismuth sulfide (Bi_2S_3), which has a solubility of 1.0×10^{-15} mol/L at 25°C .

[6]

7.5 'n Monster van 10.00 g wat bestaan uit 'n mengsel van natriumchloried en kaliumsulfaat word opgelos in water. Hierdie waterige oplossing reageer met oormaat lood(II)nitraat om 21,75 g vastestof te vorm. Bepaal die massa persentasie van die natriumchloried in die oorspronklike mengsel.

A 10.00 g sample consisting of a mixture of sodium chloride and potassium sulfate is dissolved in water. This aqueous mixture then reacts with excess aqueous lead(II) nitrate to form 21.75 g of solid. Determine the mass percent of sodium chloride in the original mixture.

[11]

PERIODIC TABLE OF THE ELEMENTS
PERIODIEKE INDELING VAN DIE ELEMENTE

IA (1)																	0 (18)
1 H 1,01																	2 He 4,00
3 Li 6,94	4 Be 9,01											5 B 10,8	6 C 12,0	7 N 14,0	8 O 16,0	9 F 19,0	10 Ne 20,2
11 Na 23,0	12 Mg 24,3	13 Al 27,0	atomic number / atoomgetal symbol / simbool atomic mass / atoommassa										14 Si 28,1	15 P 31,0	16 S 32,1	17 Cl 35,45	18 Ar 39,9
19 K 39,1	20 Ca 40,1	21 Sc 45,0	22 Ti 47,9	23 V 50,9	24 Cr 52,0	25 Mn 54,9	26 Fe 55,9	27 Co 58,9	28 Ni 58,7	29 Cu 63,4	30 Zn 65,4	31 Ga 69,7	32 Ge 72,6	33 As 74,9	34 Se 79,0	35 Br 79,9	36 Kr 83,8
37 Rb 85,5	38 Sr 87,6	39 Y 88,9	40 Zr 91,2	41 Nb 92,9	42 Mo 95,9	43 Tc (98)	44 Ru 101,1	45 Rh 102,9	46 Pd 106,4	47 Ag 107,9	48 Cd 112,4	49 In 114,8	50 Sn 118,7	51 Sb 121,6	52 Te 127,6	53 I 127,9	54 Xe 131,3
55 Cs 132,9	56 Ba 137,3	57 La 138,9	* 72 Hf 178,5	73 Ta 180,9	74 W 183,9	75 Re 186,2	76 Os 190,2	77 Ir 192,2	78 Pt 195,1	79 Au 197,0	80 Hg 200,6	81 Tl 204,4	82 Pb 207,2	83 Bi 209,0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226,0	89 Ac 227,0	# 104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)									
lanthanides / lantaniede			58 Ce 140,1	59 Pr 140,9	60 Nd 144,2	61 Pm (145)	62 Sm 150,4	63 Eu 152,0	64 Gd 157,3	65 Tb 158,9	66 Dy 162,5	67 Ho 164,9	68 Er 167,3	69 Tm 168,9	70 Yb 173,0	71 Lu 175,0	
actinides / aktiniede			90 Th 232,0	91 Pa 231,0	92 U 238,0	93 Np 237,0	94 Pu (244)	95 Am (244)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (258)	103 Lr (260)	

TABEL 1: Oplosbaarheidstabel.**TABLE 1: Solubility Table.**

Soluble compounds		Exceptions
Almost all salts of Na^+ , K^+ and NH_4^+		
All salts of Cl^- , Br^- and I^-	\Leftrightarrow	Halides of Ag^+ , Hg_2^{2+} and Pb^{2+}
Compounds containing F^-	\Leftrightarrow	Fluorides of Mg^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} and Pb^{2+}
Salts of nitrate, NO_3^- ; chlorate, ClO_3^- ; perchlorate, ClO_4^- ; acetate, CH_3COO^-		KClO_4
Salts of sulfate, SO_4^{2-}	\Leftrightarrow	Sulfates of Sr^{2+} , Ba^{2+} and Pb^{2+}

Insoluble compounds		Exceptions
All salts of carbonate, CO_3^{2-} ; phosphate, PO_4^{3-} ; oxalate, $\text{C}_2\text{O}_4^{2-}$; chromate, CrO_4^{2-} ; sulfide, S^{2-} ; Most metal hydroxides OH^- and oxides, O^{2-}	\Leftrightarrow	Salts of NH_4^+ and alkali metal cations

TABEL 2: Geselekteerde Termodinamiese Waardes.**TABLE 2: Selected Thermodynamic Values.**

Species	$\Delta_f H^\circ$ (298.15 K) (kJ/mol)	S° (298.15 K) (J/K.mol ⁻¹)	$\Delta_f G^\circ$ (298.15 K) (kJ/mol)
CCl ₄ (ℓ)	-128.4	214.39	- 57.63
CCl ₄ (g)	-95.98	309.65	- 53.61
CH ₄ (g)	-74.87	186.26	- 50.8
H ₂ (g)	0	130.7	0
Al (s)	0	28.3	0
Al ₂ O ₃ (s)	-1675.7	50.92	- 1582.3
N ₂ (g)	0	191.56	0
I ₂ (s)	0	116.135	0
Fe (s)	0	27.78	0
Fe ₂ O ₃ (s)	- 825.5	87.40	- 742.2
CH ₃ OH (ℓ)	-238.4	127.19	- 166.14
CH ₃ OH (g)	-201.0	239.7	- 162.5
CO (g)	-110.525	197.674	- 137.168
CO ₂ (g)	-393.509	213.74	- 394.359
O ₂ (g)	0	205.07	0
H ₂ O (ℓ)	-285.83	69.95	- 237.15
H ₂ O (g)	-241.83	188.84	- 228.59

TABEL 3: Oplosbaarheidsprodukt Konstantes.

TABLE 3: Solubility Produce Constants.

TABLE 18A Solubility Produce Constants (25 °C)

Cation	Compound	K_{sp}	Cation	Compound	K_{sp}
Ba^{2+}	*BaCrO ₄	1.2×10^{-10}	Mg^{2+}	MgCO ₃	6.8×10^{-6}
	BaCO ₃	2.6×10^{-9}		MgF ₂	5.2×10^{-11}
	BaF ₂	1.8×10^{-7}		Mg(OH) ₂	5.6×10^{-12}
	Ca^{2+}	*BaSO ₄	1.1×10^{-10}	Mn^{2+}	MnCO ₃
CaCO ₃ (calcite)		3.4×10^{-9}	*Mn(OH) ₂		1.9×10^{-13}
*CaF ₂		5.3×10^{-11}	Hg_2^{2+}	*Hg ₂ Br ₂	6.4×10^{-23}
*Ca(OH) ₂		5.5×10^{-5}		Hg ₂ Cl ₂	1.4×10^{-18}
CaSO ₄	4.9×10^{-5}	*Hg ₂ I ₂		2.9×10^{-29}	
$Cu^{+}, 2+$	CuBr	6.3×10^{-9}	Ni^{2+}	Hg ₂ SO ₄	6.5×10^{-7}
	CuI	1.3×10^{-12}		NiCO ₃	1.4×10^{-7}
	Cu(OH) ₂	2.2×10^{-20}		Ni(OH) ₂	5.5×10^{-16}
	CuSCN	1.8×10^{-13}	Ag^+	*AgBr	5.4×10^{-13}
Au^+	AuCl	2.0×10^{-13}		*AgBrO ₃	5.4×10^{-5}
	Fe^{2+}	FeCO ₃		3.1×10^{-11}	AgCH ₃ CO ₂
Fe(OH) ₂		4.9×10^{-17}		AgCN	6.0×10^{-17}
Pb^{2+}	PbBr ₂	6.6×10^{-6}		Ag ₂ CO ₃	8.5×10^{-12}
	PbCO ₃	7.4×10^{-14}		*Ag ₂ C ₂ O ₄	5.4×10^{-12}
	PbCl ₂	1.7×10^{-5}		*AgCl	1.8×10^{-10}
	PbCrO ₄	2.8×10^{-13}	Ag ₂ CrO ₄	1.1×10^{-12}	
	PbF ₂	3.3×10^{-8}	*AgI	8.5×10^{-17}	
	PbI ₂	9.8×10^{-9}	AgSCN	1.0×10^{-12}	
	Pb(OH) ₂	1.4×10^{-15}	*Ag ₂ SO ₄	1.2×10^{-5}	
	PbSO ₄	2.5×10^{-8}			

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TABEL 4: Suur en Basiese Eienskappe van Sommige Ione in Waterige Oplossing.

TABLE 4: Acid and Base Properties of Some Ions in Aqueous Solution.

TABLE 17.4 Acid and Base Properties of Some Ions in Aqueous Solution

Neutral			Basic			Acidic
Anions	Cl ⁻	NO ₃ ⁻	CH ₃ CO ₂ ⁻	CN ⁻	SO ₄ ²⁻	HSO ₄ ⁻
	Br ⁻	ClO ₄ ⁻	HCO ₂ ⁻	PO ₄ ³⁻	HPO ₄ ²⁻	H ₂ PO ₄ ⁻
	I ⁻		CO ₃ ²⁻	HCO ₃ ⁻	SO ₃ ²⁻	HSO ₃ ⁻
			S ²⁻	HS ⁻	OCl ⁻	
			F ⁻	NO ₂ ⁻		
Cations	Li ⁺		[Al(H ₂ O) ₅ (OH)] ²⁺ (for example)			[Al(H ₂ O) ₆] ³⁺ and hydrated transition metal cations (such as [Fe(H ₂ O) ₆] ³⁺)
	Na ⁺	Ca ²⁺				
	K ⁺	Ba ²⁺				NH ₄ ⁺

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Table 16.2 Ionization Constants for Some Acids and Their Conjugate Bases at 25 °C

ACID NAME	ACID	K_a	BASE	K_b	BASE NAME
Perchloric acid	HClO ₄	Large	ClO ₄ ⁻	Very small	Perchlorate ion
Sulfuric acid	H ₂ SO ₄	Large	HSO ₄ ⁻	Very small	Hydrogen sulfate ion
Hydrochloric acid	HCl	Large	Cl ⁻	Very small	Chloride ion
Nitric acid	HNO ₃	Large	NO ₃ ⁻	Very small	Nitrate ion
Hydronium ion	H ₃ O ⁺	1.0	H ₂ O	1.0×10^{-14}	Water
Sulfurous acid	H ₂ SO ₃	1.2×10^{-2}	HSO ₃ ⁻	8.3×10^{-13}	Hydrogen sulfite ion
Hydrogen sulfate ion	HSO ₄ ⁻	1.2×10^{-2}	SO ₄ ²⁻	8.3×10^{-13}	Sulfate ion
Phosphoric acid	H ₃ PO ₄	7.5×10^{-3}	H ₂ PO ₄ ⁻	1.3×10^{-12}	Dihydrogen phosphate ion
Hexaaquairon(III) ion	[Fe(H ₂ O) ₆] ³⁺	6.3×10^{-3}	[Fe(H ₂ O) ₅ OH] ²⁺	1.6×10^{-12}	Pentaaquahydroxoiron(III) ion
Hydrofluoric acid	HF	7.2×10^{-4}	F ⁻	1.4×10^{-11}	Fluoride ion
Nitrous acid	HNO ₂	4.5×10^{-4}	NO ₂ ⁻	2.2×10^{-11}	Nitrite ion
Formic acid	HCO ₂ H	1.8×10^{-4}	HCO ₂ ⁻	5.6×10^{-11}	Formate ion
Benzoic acid	C ₆ H ₅ CO ₂ H	6.3×10^{-5}	C ₆ H ₅ CO ₂ ⁻	1.6×10^{-10}	Benzoate ion
Acetic acid	CH ₃ CO ₂ H	1.8×10^{-5}	CH ₃ CO ₂ ⁻	5.6×10^{-10}	Acetate ion
Propanoic acid	CH ₃ CH ₂ CO ₂ H	1.3×10^{-5}	CH ₃ CH ₂ CO ₂ ⁻	7.7×10^{-10}	Propanoate ion
Hexaaquaaluminum ion	[Al(H ₂ O) ₆] ³⁺	7.9×10^{-6}	[Al(H ₂ O) ₅ OH] ²⁺	1.3×10^{-9}	Pentaaquahydroxoaluminum ion
Carbonic acid	H ₂ CO ₃	4.2×10^{-7}	HCO ₃ ⁻	2.4×10^{-8}	Hydrogen carbonate ion
Hexaaquacopper(II) ion	[Cu(H ₂ O) ₆] ²⁺	1.6×10^{-7}	[Cu(H ₂ O) ₅ OH] ⁺	6.3×10^{-8}	Pentaaquahydroxocopper(II) ion
Hydrogen sulfide	H ₂ S	1×10^{-7}	HS ⁻	1×10^{-7}	Hydrogen sulfide ion
Dihydrogen phosphate ion	H ₂ PO ₄ ⁻	6.2×10^{-8}	HPO ₄ ²⁻	1.6×10^{-7}	Hydrogen phosphate ion
Hydrogen sulfite ion	HSO ₃ ⁻	6.2×10^{-8}	SO ₃ ²⁻	1.6×10^{-7}	Sulfite ion
Hypochlorous acid	HClO	3.5×10^{-8}	ClO ⁻	2.9×10^{-7}	Hypochlorite ion
Hexaaqualead(II) ion	[Pb(H ₂ O) ₆] ²⁺	1.5×10^{-8}	[Pb(H ₂ O) ₅ OH] ⁺	6.7×10^{-7}	Pentaaquahydroxolead(II) ion
Hexaaquacobalt(II) ion	[Co(H ₂ O) ₆] ²⁺	1.3×10^{-9}	[Co(H ₂ O) ₅ OH] ⁺	7.7×10^{-6}	Pentaaquahydroxocobalt(II) ion
Boric acid	B(OH) ₃ (H ₂ O)	7.3×10^{-10}	B(OH) ₄ ⁻	1.4×10^{-5}	Tetrahydroxoborate ion
Ammonium ion	NH ₄ ⁺	5.6×10^{-10}	NH ₃	1.8×10^{-5}	Ammonia
Hydrocyanic acid	HCN	4.0×10^{-10}	CN ⁻	2.5×10^{-5}	Cyanide ion
Hexaaquairon(II) ion	[Fe(H ₂ O) ₆] ²⁺	3.2×10^{-10}	[Fe(H ₂ O) ₅ OH] ⁺	3.1×10^{-5}	Pentaaquahydroxoiron(II) ion
Hydrogen carbonate ion	HCO ₃ ⁻	4.8×10^{-11}	CO ₃ ²⁻	2.1×10^{-4}	Carbonate ion
Hexaaquanickel(II) ion	[Ni(H ₂ O) ₆] ²⁺	2.5×10^{-11}	[Ni(H ₂ O) ₅ OH] ⁺	4.0×10^{-4}	Pentaaquahydroxonickel(II) ion
Hydrogen phosphate ion	HPO ₄ ²⁻	3.6×10^{-13}	PO ₄ ³⁻	2.8×10^{-2}	Phosphate ion
Water	H ₂ O	1.0×10^{-14}	OH ⁻	1.0	Hydroxide ion
Hydrogen sulfide ion*	HS ⁻	1×10^{-19}	S ²⁻	1×10^5	Sulfide ion
Ethanol	C ₂ H ₅ OH	Very small	C ₂ H ₅ O ⁻	Large	Ethoxide ion
Ammonia	NH ₃	Very small	NH ₂ ⁻	Large	Amide ion
Hydrogen	H ₂	Very small	H ⁻	Large	Hydride ion

*The values of K_a for HS⁻ and K_b for S²⁻ are estimates.

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