



Benodigdhede 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"/>
Rofwerkpapier/ Scrap paper:	<input type="checkbox"/>	Grafiekpapier/ Graph paper:	<input type="checkbox"/>

Sakrekenaars/Calculators: Ja/Yes

Ander hulpmiddels/Other resources:

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

Tipe Assessering/
Type of Assessment:

**Eksamen 2e geleentheid
Exam 2nd opportunity
Vraestel/Paper 2**

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

Modulekode/
Module code:

CHEM111

Tyd/duur/
Duration: **3 uur
3 hour**

Module beskrywing/
Module description:

Inleidende Anorganiese en Fisiese Chemie

Maks/
Max: **102**

Eksaminator(e)/
Examiner(s):

Dr C.E. Read

Datum/
Date: **11/07/2017**

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 Skryf formule of die naam vir die volgende verbindings. / Write the formula or the name for the following compounds. **[3]**

Naam van verbinding. <i>Name of compound.</i>	Formule van verbinding. <i>Formula of compound.</i>
Silwer(I)oksied / <i>Silver(I) oxide</i>	
Bariumperchloraat / <i>Barium perchlorate</i>	
	Co(CN) ₃

- 1.2 Watter van die volgende atome het die grootste aantal protone? / Which of the following atoms contains the largest number of protons? **[1]**

- a. ²²⁶Ra b. ²²⁷Ac c. ²³²Th d. ²³¹Pa
e. ²²²Rn

- 1.3 Watter van die volgende is korrek vir 'n element met 28 protone en 31 neutrone? / Which of the following is correct for an element with 28 protons and 31 neutrons?

[1]

- a. ⁵⁹₃₁Ga b. ³¹₂₈Ni c. ²⁸₅₉Pr d. ⁵⁹₂₈Ni
e. ³¹₃Li

- 1.4 Fe_x(CO)_y bestaan uit 30,70% yster. Bereken die eenvoudigste (empiriese) formule van die verbinding. Fe_x(CO)_y consists of 30,70% iron. Calculate the simplest (empirical) formula of the compound. **[5]**

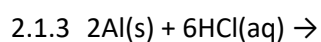
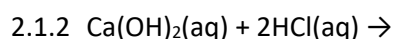
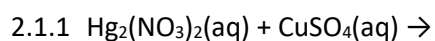
Vraag 2. / Question 2.

[12 PUNTE. / 12 MARKS.]

CHEMIESE REAKSIES. / CHEMICAL REACTIONS.

- 2.1 Voltooi en benoem die chemiese reaksietipes van die volgende reaksies in waterige oplossings:
Complete and name the chemical reaction types of the following reactions in aqueous solution:

[6]



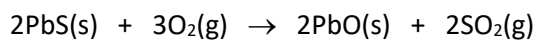
- 2.2 Balanseer die volgende oksidasie-reduksiereaksie, wat in 'n basiese oplossing plaasvind deur van die half-reaksiemetode gebruik te maak. / *Balance the following oxidation-reduction reaction which occurs in basic solution using the half-reaction method.*

[6]



STOIGIOMETRIE. / STOICHIOMETRY.

3.1 Gegewe die volgende vergelyking: / Given the following equation:



Indien 100 g PbS(s) reageer met 150 g O₂(g) en slegs 43 g PbO(s) word gevorm, wat is die persentasie opbrengs van die reaksie? / If 100 g PbS(s) react with 150 g O₂(g) and only 43 g PbO(s) is formed, what is the percentage yield of the reaction? [6]

(Gegee: / Given: $M_{\text{PbS}} = 239.3 \text{ g}\cdot\text{mol}^{-1}$; $M_{\text{O}_2} = 32 \text{ g}\cdot\text{mol}^{-1}$; $M_{\text{PbO}} = 223.2 \text{ g}\cdot\text{mol}^{-1}$).

3.2 Gekonsentreerde swaelsuur ($98.12 \text{ g}\cdot\text{mol}^{-1}$) het 'n digtheid van $1.5 \text{ g}/\text{cm}^3$ en is 60 % H₂SO₄ per massa. Die res is water. Bereken die molaliteit van die suur. / Concentrated sulphuric acid ($98.12 \text{ g}\cdot\text{mol}^{-1}$) has a density of $1.5 \text{ g}/\text{cm}^3$ and is 60 % H₂SO₄ per mass. The rest is water. Calculate the molality of the acid.

[4]

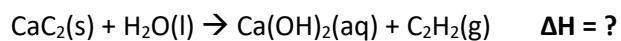
Vraag 4. / Question 4.**[10 PUNTE. / 10 MARKS.]****ENERGIEOORDRAG (TERMODINAMIKA). / ENERGY TRANSFER (THERMODINAMICS).**

4.1 Gegewe die volgende data: / Given the following data:

[4]

- | | | |
|-------|---|---------------------------------|
| (i) | $\text{Ca(s)} + 2\text{C(grafite)} \rightarrow \text{CaC}_2\text{(s)}$ | $\Delta H = -62.8 \text{ kJ}$ |
| (ii) | $\text{Ca(s)} + \frac{1}{2}\text{O}_2\text{(g)} \rightarrow \text{CaO(s)}$ | $\Delta H = -635.5 \text{ kJ}$ |
| (iii) | $\text{CaO(s)} + \text{H}_2\text{O(l)} \rightarrow \text{Ca(OH)}_2\text{(aq)}$ | $\Delta H = -653.1 \text{ kJ}$ |
| (iv) | $\text{C}_2\text{H}_2\text{(g)} + 5/2\text{O}_2\text{(g)} \rightarrow 2\text{CO}_2\text{(g)} + \text{H}_2\text{O(l)}$ | $\Delta H = -1300.0 \text{ kJ}$ |
| (v) | $\text{C(grafite)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$ | $\Delta H = -393.5 \text{ kJ}$ |

Bereken ΔH vir die volgende reaksie, deur van Hess se wet en manipulasie van die gegewe reaksies gebruik te maak. / Calculate ΔH for the following reaction by using Hess's law and manipulating the given reactions:



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

[2]

- 4.3 'n Stukkie chroom (15.5 g) word verhit tot 100.0 °C (373.15 K) en dan in 55.5 g water by 16.5 °C (289.65 K) laat val. Die finale temperatuur van die metaal en water is 18.9 °C. Bereken die spesifieke hittekapasiteit van chroom. Aanvaar dat geen energie verlore gegaan het na die houer of die omringende lug nie. Die spesifieke hittekapasiteit van water is 4.184 J/g.K. / *A 15.5 g piece of chromium is heated to 100.0 °C (373.15 K) and is then dropped into 55.5 g of water at 16.5 °C (289.65 K). The final temp. of the metal and water is 18.9 °C. Calculate the specific heat capacity of chromium. Assume no energy is lost to the container or to the surrounding air. The specific heat capacity of water is 4.184 J/g.K.* [4]

Vraag 5. / Question 5.

[20 PUNTE. / 20 MARKS.]

CHEMIESE EWEWIG. / CHEMICAL EQUILIBRIUM.

- 5.1 K_c vir die ontbinding van ammoniumwaterstofsulfied is 1.8×10^{-4} by 25°C. / *K_c for the decomposition of ammonium hydrogen sulfide is 1.8×10^{-4} at 25°C.*



- 5.1.1 Bereken die ewewigskonsentrasies van beide produkte wanneer die suiwer sout in 'n fles ontbind. / *Calculate the equilibrium concentrations of both products when the pure salt decomposes in a flask.*

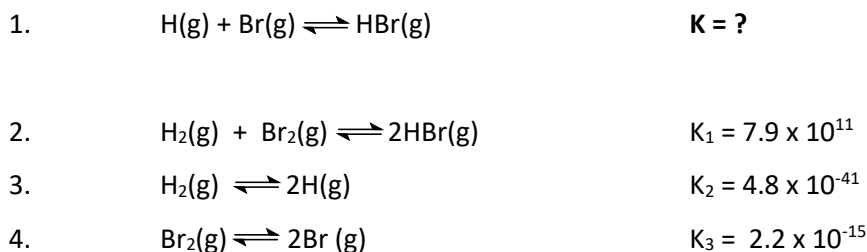
[2]

5.1.2 Indien NH_4HS in 'n fles geplaas word wat reeds 0.020 mol/L NH_3 bevat en die sisteem word dan toegelaat om ewewig te bereik, bereken dan die ewewigskonsentrasies van NH_3 en H_2S .

If NH_4HS is placed in a flask already containing 0.020 mol/L of NH_3 and then the system is allowed to come to equilibrium, calculate the equilibrium concentrations of NH_3 and H_2S ? [4]

5.2 Koolstofmonoksied reageer met stoom om koolstofdoksied en waterstofgas te produseer. By 700 K is die ewewigskonstante gelyk aan 5.10 . Bereken die ewewigskonsentrasies van al die spesies indien die reaksie met 1.00 mol.L^{-1} van elk begin is. / *Carbon monoxide reacts with steam to yield carbon dioxide and hydrogen gas. At 700 K the equilibrium constant is equal to 5.10 . Calculate the equilibrium concentrations of all the species if the reaction was started with 1.00 mol.L^{-1} of each. [7]*

5.3 Bepaal die ewewigskonstante K vir die vorming van HBr volgens die reaksie genummer 1 hieronder deur van die ewewigskonstantes van die reaksies genummer 2 tot 4 gebruik te maak. / *Determine the equilibrium constant K for the formation of HBr according to the reaction numbered 1 below by using the equilibrium constants of the reactions numbered 2 to 4.* [5]



5.4 Sal jy (op grond van jou antwoord in vraag 5.3) sê dat reaksie nommer 1 'n hoë produkopbrengs sal hê? Omkring JA of NEE en gee 'n rede vir jou antwoord. / *Will you (on the basis of your answer in question 5.3) say that reaction number 1 will have a high product yield? Circle YES or NO and give a reason for your answer.* [2]

JA. (YES).

NEE. (NO).

Vraag 6. / Question 6.

[20 PUNTE. / 20 MARKS.]

SURE EN BASISSE. / ACIDS AND BASES.

6.1 Bereken die massa KOH wat nodig is om 'n 800.0 mL oplossing met 'n pH = 11.56 voor te berei.

Calculate the mass of KOH necessary to prepare 800.0 mL of a solution that has a pH = 11.56.

[4]

6.2 Sitroensuur ($H_3C_6H_5O_7$) is 'n triprotiese suur met $K_{a1} = 8.4 \times 10^{-4}$; $K_{a2} = 1.8 \times 10^{-5}$ en $K_{a3} = 4.0 \times 10^{-6}$.

Bereken die pH van 'n 0.15 M sitroensuurooplossing. / *Citric acid ($H_3C_6H_5O_7$) is a tri-protic acid with $K_{a1} = 8.4 \times 10^{-4}$; $K_{a2} = 1.8 \times 10^{-5}$ and $K_{a3} = 4.0 \times 10^{-6}$. Calculate the pH of a 0.15 M citric acid solution.*

[5]

6.3 In 'n waterige oplossing wat 10^{-8} M soutsuur (HCl) en 10^{-8} M asynsuur (CH_3COOH) bevat sal die H^+ -ione hoofsaaklik verskaf word deur / *In an aqueous solution containing 10^{-8} M (hydrochloric acid) HCl and 10^{-8} M acetic acid (CH_3COOH) the H^+ ions will mostly be supplied by* [1]

A) die sterk suur. / *the strong acid.*

B) die swak suur. / *the weak acid.*

C) beide die sterk en die swak sure. / *both the strong and the weak acids.*

D) water. / *water.*

6.4 Die sianiedioon, CN^- , ontvang 'n proton vanaf water om HCN te vorm. Is CN^- 'n Brønsted-Lowry suur of basis of is dit amfiproties? / *The cyanide ion, CN^- , accepts a proton from water to form HCN. Is CN^- a Brønsted-Lowry acid or base or is it amphiprotic?* [1]

6.5 Bereken die pK_a waarde van die gekonjugeerde suur van ammoniak. / *Calculate the pK_a value for the conjugate acid of ammonia?* [2]

6.6 Watter een van die volgende sure het 'n pK_a waarde van 4.20? / *Which one of the following acids has a pK_a value of 4.20?* [2]

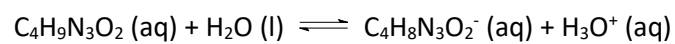
a) $\text{C}_6\text{H}_5\text{CO}_2\text{H}$

b) $\text{CH}_3\text{CO}_2\text{H}$

c) HCO_2H

d) HF

- 6.7 'n 0.450 M waterige oplossing van kreatien, ($C_4H_9N_3O_2$), het 'n pH van 1.49. Bereken die waarde van die ewewigskonstante sowel as die pK_a waarde van kreatien. / *A 0.450 M aqueous solution of creatine, ($C_4H_9N_3O_2$), has a pH of 1.49. Calculate the value of the equilibrium constant as well as the pK_a value for creatine.* [5]



Vraag 7. / Question 7.

[20 PUNTE. / 20 MARKS.]

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

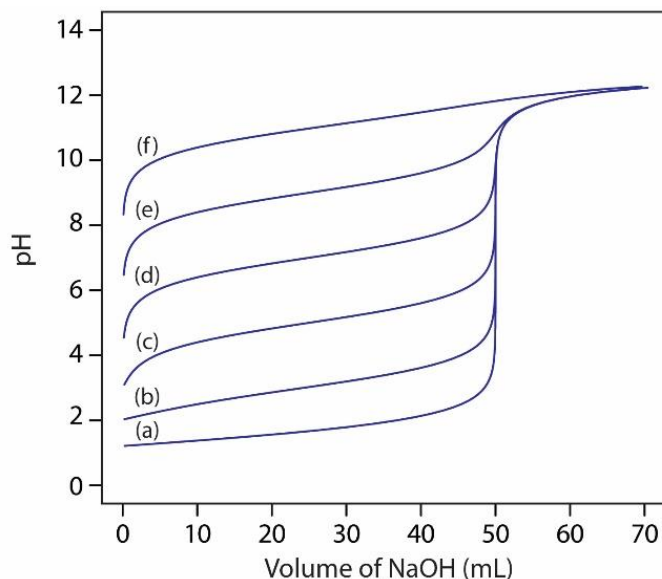
- 7.1 Die oplosbaarheidsproduk-konstante van kadmiumfluoried (CdF_2) is 6.44×10^{-3} by 25°C . Bereken die hoeveelheid (in gram en in milligram) CdF_2 wat sal oplos in 'n half liter water by 25°C . / The solubility product constant of cadmium fluoride (CdF_2) is 6.44×10^{-3} at 25°C . Calculate the amount (in gram and in milligram) of CdF_2 that will dissolve in half a litre of water at 25°C . **[6]**

(Gegee: / Given: $M_{\text{H}_2\text{O}} = 18.02 \text{ g.mol}^{-1}$ en/and $M_{\text{CdF}_2} = 150.38 \text{ g.mol}^{-1}$)

7.2 Definieer 'n bufferoplossing. Van wat word 'n bufferoplossing berei? Beskryf hoe buffers bygevoegde H^+ - en OH^- -ione absorbeer sodat 'n baie klein pH verandering plaasvind. 'n Sekere buffer is berei deur $NaHCO_3$ en $NaCO_3$ in water op te los. Skryf reaksievergelykings neer wat wys hoe die buffer bygevoegde H^+ - en OH^- -ione sal neutraliseer.

Define a buffer solution. What makes up a buffered solution? Explain how buffers absorb added H^+ or OH^- with little pH change. A certain buffer is made by dissolving $NaHCO_3$ and Na_2CO_3 in some water. Write equations to show how this buffer neutralizes added H^+ and OH^- . **[6]**

- 7.3 Die volgende grafiek wys die pH kurwes vir titrasies van verskeie sure met 0.10 M NaOH (al die sure was 50.0 mL monsters met konsentrasies van 0.10 M). / *The following plot shows the pH curves for the titrations of various acids with 0.10 M NaOH (all the acids were 50,0 mL samples of 0.10 M concentration).*



- 7.3.1 Watter pH kurwe stem ooreen met die swakste suur? Gee 'n rede vir jou antwoord. / *Which pH curve corresponds to the weakest acid? Give a reason for your answer.* [2]

- 7.3.2 Watter pH kurwe stem ooreen met die sterkste suur? Gee 'n rede vir jou antwoord. / *Which pH curve corresponds to the strongest acid? Give a reason for your answer.* [2]

- 7.3.3 Watter punt op die pH kurwe sal jy bestudeer om te sien of die suur 'n sterk suur of 'n swak suur is? / *Which point on the pH curve would you examine to see if the acid is a strong acid or a weak acid?* [2]

7.3.4 Watter pH kurwe stem ooreen met 'n suur met 'n $K_a = 1 \times 10^{-6}$? Gee 'n rede vir jou antwoord.

Which pH curve corresponds to an acid with $K_a = 1 \times 10^{-6}$? Give a reason for your answer. **[2]**

JY MAG VANAF BLADSY 18 TOT DIE LAASTE BLADSY AFSKEUR VIR GEBRUIK. MOET DIT NIE SAAM MET JOU VRAESTEL INHANDIG NIE. JY KAN DIT WEGGOOI NA AFLOOP VAN DIE VRAESTEL. / YOU MAY TEAR OFF PAGE 18 TO THE LAST PAGE TO USE. DO NOT HAND THEM IN WITH YOUR PAPER. YOU MAY THROUGH THEM AWAY AFTER COMPLETING THE PAPER.

PERIODIC TABLE OF THE ELEMENTS
PERIODIEKE INDELING VAN DIE ELEMENTE

IA (1)	IIA (2)											IIIA (13)	IVA (14)	VA (15)	VIA (16)	VIIA (17)	0 (18)
1 H 1,01												5 B 10,8	6 C 12,0	7 N 14,0	8 O 16,0	9 F 19,0	10 Ne 20,2
3 Li 6,94	4 Be 9,01											13 Al 27,0	14 Si 28,1	15 P 31,0	16 S 32,1	17 Cl 35,45	18 Ar 39,9
11 Na 23,0	12 Mg 24,3	III B (3)	IV B (4)	VB (5)	VIB (6)	VIIB (7)	VIII (8) (9) (10)		IB (11)	IIB (12)		13 Al 27,0	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 (234)	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 ⁻	↔	Halides of Ag ⁺ , Hg ₂ ²⁺ and Pb ²⁺
Compounds containing F ⁻	↔	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 ₃ COO ⁻		KClO ₄
Salts of sulfate, SO ₄ ²⁻	↔	Sulfates of Sr ²⁺ , Ba ²⁺ and Pb ²⁺

Insoluble compounds		Exceptions
All salts of carbonate, CO ₃ ²⁻ ; phosphate, PO ₄ ³⁻ ; oxalate, C ₂ O ₄ ²⁻ ; chromate, CrO ₄ ²⁻ ; sulfide, S ²⁻ ; Most metal hydroxides OH ⁻ and oxides, O ²⁻	↔	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 Product Constants.

TABLE 18A Solubility Product 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_2Br_2	6.4×10^{-23}
* $Ca(OH)_2$		5.5×10^{-5}		Hg_2Cl_2	1.4×10^{-18}
$CaSO_4$		4.9×10^{-5}		* Hg_2I_2	2.9×10^{-29}
$Cu^{+}, 2+$	$CuBr$	6.3×10^{-9}	Hg_2SO_4	6.5×10^{-7}	
	CuI	1.3×10^{-12}	Ni^{2+}	$NiCO_3$	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}	$AgCH_3CO_2$
$Fe(OH)_2$		4.9×10^{-17}	$AgCN$	6.0×10^{-17}	
Pb^{2+}	$PbBr_2$	6.6×10^{-6}	Ag_2CO_3	8.5×10^{-12}	
		7.4×10^{-14}	* $Ag_2C_2O_4$	5.4×10^{-12}	
		1.7×10^{-5}	* $AgCl$	1.8×10^{-10}	
		2.8×10^{-13}	Ag_2CrO_4	1.1×10^{-12}	
		3.3×10^{-8}	* AgI	8.5×10^{-17}	
		9.8×10^{-9}	$AgSCN$	1.0×10^{-12}	
		1.4×10^{-15}	* Ag_2SO_4	1.2×10^{-5}	
		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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