NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOMKAMPUS

Requirements for this paper:					
Multi choice cards:		Non-programmable calculator:	X	Open book examination	
Graphic paper:		Laptop:			

EKSAMEN: EXAMINATION:	Semestertoets. / *Semester Test.*	KWALIFIKASIE. QUALIFICATION:	**B.Sc. / B.Ing.** **B.Pharm.**
MODULEKODE: MODULE CODE:	**CHEM 111**	DUUR: / DURATION:	1½ uur / *1½ hours*
MODULE NAAM: MODULE NAME:	Inleidende Anorganiese en Fisiese Chemie *Introductory Inorganic and Physical Chemistry*	MAKSIMUM PUNT: MAXIMUM MARK:	**50**
EKSAMINATORE: EXAMINERS:	Dr. C.E. Read Mev. M.H. du Toit	DATUM: / DATE:	**25 April 2017**
		TYD: / TIME:	**08:00 – 09:30**
MODERATOR:	Dr. C.G.C.E. van Sittert		

MEMORANDUM (LEEREENHEDE 2, 3, 4 EN 5)

LEEREENHEID 2 (ATOME< IONE) = 10 PUNTE
LEEREENHEID 3 (CHEMIESE REAKSIE TIPES) = 14 PUNTE
LEEREENHEID 4 (STOIGIOMETRIE) = 17 PUNTE
LEEREENHEID 5 (ENERGIE EN CHEMIESE REAKSIES) = 9 PUNTE

EKSAMENVOORSKRIFTE

1. Kandidate stel hulle aan diskwalifikasie bloot indien hulle*:*
   1.1 enige boeke of papiere van watter aard ook al, buiten dit waarvan hulle voorsien word, in hulle besit het;
   1.2 aantekeninge maak op kladpapier of enige papier hoegenaamd buiten die amptelike skrifte waarvan hulle voorsien is (kladwerk moet in die skrif gedoen word met 'n duidelike aanduiding dat dit kladwerk is);
   1.3 'n ander kandidaat help of probeer help of hulp kry of probeer om hulp van 'n ander kandidaat te verkry, of hulle op enige manier in verbinding stel of probeer in verbinding stel met 'n ander kandidaat.
2. Geen kandidaat sal toegelaat word om die eksamenlokaal te verlaat voor die verstryking van 'n halfuur na die aanvang van die eksamen nie.
3. Geen bladsye mag uit die eksamenskrif geskeur word nie.
4. Voordat kandidate die eksamenlokaal verlaat moet eksamenskrifte aan die opsieners oorhandig word.
5. Die presensiestrokie moet voltooi word.
6. Selfone word nie toegelaat in die eksamenlokaal.

EXAMINATION INSTRUCTIONS

1. Candidates are subject to disqualification should they:
   1.1 have in their possession any books or papers of whatsoever nature, except those provided to them in the examination room;
   1.2 make notes on blotting paper or any paper whatsoever except the official answer books with which they are provided (rough work must be done in the examination book, with a clear indication that it is rough work);
   1.3 assist or attempt to assist any other candidate, or obtain or attempt to obtain assistance from any other candidate or in any manner to contact or attempt to contact any other candidate.
2. No candidate will be allowed to leave the examination room before half an hour from the start of the examination has elapsed.
3. No pages may be torn out of the examination book.
4. Before candidates leave the examination room, examination papers have to be handed to invigilators.
5. The attendance slip must be completed.
6. Cell phones are not allowed in the examiniation room.

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.

Jy mag die twee bladsye agter met die periodieke tabel en oplosbaarheidstabel daarop afskeur.

Die volgende tabelle is aangeheg:
- 'n Periodieke tabel
- 'n Oplosbaarheidstabel

READ THE FOLLOWING INSTRUCTIONS THOROUGHLY

Answers to 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 may also be used for own scribbling.

The paper must be completed in pen.

You may tear off the two pages at the back with the periodic table and the solubility table on it.

The following tables are attached:
- *A periodic table*
- *A table of solubilities*

VRAAG 1. / *QUESTION 1.*

1.1 Bereken die massapersentasie van elke element in $C_{10}H_{14}O$. / *Calculate the mass percent of each element in* $C_{10}H_{14}O$. **[3]**

Mass % C = (120/150.14) x 100 = 79.93% ✓ **mass % H = (14.14/150.14) x 100 = 9.42%** ✓

Mass % O = (16/150.14) x 100 = 10.66% ✓

1.2 Epsomsout is $MgSO_4 \cdot 7H_2O$. Wanneer dit verhit word tot 75 ^{0}C verloor dit van die water, maar nie al die water van hidrasie nie. Veronderstel jy verhit 2.465 g van die sout tot 75 ^{0}C en vind dan dat die massa nou slegs 1.744 g is. Wat is die formule van die effens gedehidreerde sout? / *Epsom salt is* $MgSO_4 \cdot 7H_2O$. *When heated to 75* ^{0}*C it loses some, but not all of its water of hydration. Suppose you heat 2.465 g of the salt to 75* ^{0}*C and find that the mass is now only 1.744 g. What is the formula of the slightly dehydrated salt?* **[5]**

(**Gegee: / *Given*:** M_{H2O} = 18.02 g.mol^{-1}; $M_{MgSO4.7H2O}$ = 246.54 g.mol^{-1})

2.465 - 1.744 = <u>0.721 g water</u> ✓

n_{water} = 0.721 g / 18.02 g.mol^{-1} = <u>0.0400 mol water</u> ✓

$n_{MgSO4.7H2O}$ = 2.465 g / 246.54 g.mol^{-1} = <u>0.00999 mol</u> ✓

molverhouding tussen verlore water en sout voor verhitting: (mole ratio)

0.0400 H_2O / 0.00999 $MgSO_4.7H_2O$ = 4 H_2O : 1 $MgSO_4 \cdot 7H_2O$ ✓

4 mol water is vrygestel tydens die verhittingsproses, dus is daar 3 mol water oor.

DUS: $MgSO_4 \cdot 3H_2O$ ✓

1.3 Skryf die naam of formule van die volgende verbindings neer: / *Write down the name or formula of the following compounds:* **[2]**

Formule. / *Formula.*	**Naam. / *Name.***
$CaSO_4$	***Kalsiumsulfaat. / Calsium sulfate.*** ✓
$Al(ClO_3)_3$ ✓	Aluminiumchloraat. / *Aluminium chlorate*

VRAAG 2. / *QUESTION 2.*

Skryf 'n gebalanseerde reaksievergelyking met fisiese toestande vir al die reagense en produkte vir die volgende reaksie neer. Sien oplosbaarheidstabel agter in die vraestel. / Write down a b*alanced reaction equation with the physical states for all the reagents and products of the following reaction. See solubility table at the back of the paper.* **[3]**

Waterige oplossings van ammoniumkarbonaat en koper(II)nitraat word bymekaar gevoeg. / *Aqueous solutions of ammonium carbonate and copper(II) nitrate are added together.*

$(NH_4)_2CO_3(aq) + Cu(NO_3)_2(aq) \rightarrow CuCO_3(s) + 2\ NH_4NO_3(aq)$

'n Halwe punt vir elke reagens met fisiese toestand en 'n halfpunt vir elke produk en fisiese toestand. / *Half a mark for each reagent with physical state and half a mark each for the product with physical state.*

VRAAG 3. / *QUESTION 3.*

Klassifiseer die volgende twee reaksies as presipitasiereaksies, neutralisasiereaksies, oksidasiereaksies, reduksiereaksies, termiese dekomposisiereaksies, gasvormingsreaksies of as nie een van genoemde reaksies nie deur slegs 'n kruis in die betrokke blokkie te trek. Indien jy dink dat 'n reaksie van meer as een tipe is, moet jy kruise in al die betrokke blokkies trek. Gee dan ook redes vir jou antwoorde. / *Classify the following two reactions as precipitation reactions, neutralisation reactions, oxidation reactions, reduction reactions, thermal decomposition reactions, gas formation reactions or not one of the mentioned reactions by only drawing a cross in the appropriate box. If you think that a reaction is of more than one type then you must draw crosses in all the appropriate boxes. Also give reasons for your answers.* **[6]**

3.1 **$Fe(OH)_3(s) + HClO_3(aq) \rightarrow Fe(ClO_3)_3(aq) + 3H_2O(l)$**

- ☐ presipitasiereaksie. / *precipitation reaction.*
- ★ **neutralisasiereaksie. / *neutralisation reaction.*** ✓
- ☐ oksidasiereaksie. / *oxidation reaction.*
- ☐ reduksiereaksie. / *reduction reaction.*
- ☐ termiese dekomposisiereaksie. / *thermal decomposition reaction.*
- ☐ gasvormingsreaksie. / *gas formation reaction.*
- ☐ nie een van bogenoemde reaksies nie. / *not one of the above mentioned reactions.*

Redes: / *Reasons:* **Suur-basis reaksie daarom neutralisasie want water is een van die produkte.** ✓

3.2 **$Mn(s) + 2HNO_3(aq) \rightarrow Mn(NO_3)_2(aq) + H_2(g)$**

- ☐ presipitasiereaksie. / *precipitation reaction.*
- ☐ neutralisasiereaksie. / *neutralisation reaction.*
- ★ **oksidasiereaksie. / *oxidation reaction.***
- ★ **reduksiereaksie. / *reduction reaction.*** ✓
- ☐ termiese dekomposisiereaksie. / *thermal decomposition reaction.*
- ★ **gasvormingsreaksie. / *gas formation reaction.*** ✓
- ☐ nie een van bogenoemde reaksies nie. / *not one of the above mentioned reactions.*

Both oxidation and reduction must be chosen. If only one of the two is chosen NO MARKS!!!

Redes: / *Reasons:* **Die oksidasiegetalle van Mn (0 na 2+) en waterstof (+1 na 0) verander tydens die reaksie.** ✓

Mn word geoksideer ✓

Waterstof word gereduseer. ✓

Ook gasvorming a.g.v. waterstofgas wat vorm. ✓

VRAAG 4. / *QUESTION 4.*

Balanseer die volgende redoksreaksie in 'n suurmedium. Wys al jou berekeninge. / *Balance the following redox reaction occuring in acidic solution. Show all your calculations.* **[12 x ½ = 6]**

$$I^-(aq) + Cr_2O_7^{2-}(aq) \rightarrow Cr^{3+}(aq) + I_2(s)$$

$I^-(aq) + Cr_2O_7^{2-}(aq) \rightarrow Cr^{3+}(aq) + I_2(s)$ ✓

-1 +6 +3 0 ✓ ✓ ✓ ✓

Oks ½: **$2I^-(aq) \rightarrow I_2(s) + 2e^-$** ✓ **(x3)**

Red ½: **$Cr_2O_7^{2-}(aq) + 14H^+ + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$** ✓ **(x1)**

Oks ½: **$6I^-(aq) \rightarrow 3I_2(s) + 6e^-$**

Red ½: **$Cr_2O_7^{2-}(aq) + 14H^+ + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$**

$6I^-(aq) + 14H^+(aq) + Cr_2O_7^{2-}(aq) \rightarrow 3I_2(s) + 2Cr^{3+}(aq) + 7H_2O(l)$ ✓ ✓ ✓ ✓ ✓ ✓

Reagense: **Products:**

6 I **6 I**

14 H	**14 H**
2 Cr	**2 Cr**
7 O	**7 O**
+6 charge	**+6 charge**

Geen punte word vir die massa en ladingbalans gegee nie. Vir die finale gebalanseerde reaksie moet alles reg wees, m.a.w. die stoigiometriese koëffisiënte sowel as die fisiese toestande van al die reagense en produkte. Indien 'n student nie die fisiese toestande aandui nie, maar die reaksie is reg gebalanseer kry die student al die punte minus een. Indien 'n student nie al die stappe gewys het nie, maar wel reg gebalanseer het kry die student net die punte van die finale vergelyking.

No marks are given for the mass and charge balance. For the final balanced equation every thing must be correct, in other words, the stoichiometric coefficients as well as the physical states of all the reagents and products. If a student does not indicate the physical states, but the reaction is balanced correctly, the student gets all the marks minus 1. If a student does not show all the steps, but balances correctly then the student gets only the marks for the final equation.

VRAAG 5. / *QUESTION 5.*

Wat is die molariteit van 'n oplossing waarin 333 g kaliumwaterstofkarbonaat opgelos is in genoeg water om 'n 15.0 L oplossing te gee? / *What is the molarity of a solution in which 333 g potassium hydrogen carbonate is dissolved in enough water to make 15.0 L of solution?* **[3]**

M_{KHCO3} = 100.01 g.mol^{-1}

n_{KHCO3} = 333 g / 100.01 g.mol^{-1} = 3.33 mol

$c_{KHCO3} = n_{KHCO3} / V_{oplossing}$ = 3.33 mol / 15.0 L = 0.222 M $KHCO_3$

VRAAG 6. / *QUESTION 6.*

Goud(III)hidroksied word gebruik om goud op ander metale te plateer. Dit kan berei word deur die volgende gebalanseerde reaksievergelyking: / *Gold(III) hydroxide is used for electroplating gold onto other metals. It can be made by the following balanced reaction equation:*

$$2KAuCl_4\,(aq) + 3Na_2CO_3\,(aq) + 3H_2O \rightarrow 2Au(OH)_3\,(aq) + 6NaCl\,(aq) + 2KCl\,(aq) + 3CO_2\,(g)$$

Om 'n vars voorraad $Au(OH)_3$ te berei, het 'n chemikus wat by 'n elektroplaterings fabriek werk, 20.00 g $KAuCl_4$ met 25.00 g Na_2CO_3 (beide opgelos in 'n groot oormaat water) gemeng. Wat is die maksimum hoeveelheid $Au(OH)_3$, in gram, wat kan vorm? / *To prepare a fresh supply of $Au(OH)_3$, a chemist at an electroplating plant has mixed 20.00 g of $KAuCl_4$ with 25.00 g of Na_2CO_3 (both dissolved in a large excess of water). What is the maximum number of grams of $Au(OH)_3$ that can vorm?* **[5]**

(**Gegee: / *Given:*** M_{H2O} = 18.02 g.mol^{-1}; M_{KAuCL4} = 377.88 g.mol^{-1}; M_{Na2CO3} = 105.99 g.mol^{-1}; $M_{Au(OH)3}$ = 247.99 g.mol^{-1})

n_{KAuCl4} = 20.00 g / 377.88 g.mol^{-1} = 0.0529 mol $KAuCl_4$ ✓

n_{Na2CO3} = 25.00 g / 105.99 g.mol^{-1} = 0.236 mol Na_2CO_3 ✓

2 mol $KAuCl_4$: 3 mol Na_2CO_3 ✓

0.0529 mol : 0.0794 mol

'n Punt vir die aanduiding van die molverhouding as bewys van beperkende reagens.

Beperkende reagens is $KAuCl_4$ ✓

2 mol $KAuCl_4$: 2 mol $Au(OH)_3$ = 1 : 1

0.0529 mol $KAuCl_4$ will form 0.0529 mol $Au(OH)_3$ ✓

$m_{Au(OH)3}$ = n x M = 0.0529 mol x 247.99 g.mol^{-1} = 13.12 g $Au(OH)_3$ ✓

Any answer between 13.10 g and 13.13 g is correct.

VRAAG 7. / *QUESTION 7.*

Tafelwyn het 'n pH van 3.40. Wat is die hidroniumioonkonsentrasie van die wyn? / *Table wine ha sa pH of 3.40. What is the hydronium ion concentration of the wine?* **[1]**

$[H_3O^+] = 10^{-pH} = 10^{-3.40} = 0.000398$ M (3.98 x 10^{-4} M) ✓ OF $[H^+] = 10^{-pH} = 10^{-3.40} = 0.000398$ M (3.98 x 10^{-4} M)

Laat vir 'n klein speling toe op die antwoord, a.g.v. verskillende maniere van afronding.

VRAAG 8. / *QUESTION 8.*

'n Mengsel van $CuCl_2$ en $CuCl_2{\cdot}2H_2O$ het 'n massa van 1.565 g. Nadat die mengsel genoegsaam verhit is om al die water af te dryf, was die massa slegs 1.391 g. Bereken die massapersentasie $CuCl_2{\cdot}2H_2O$ in die mengsel. / *A mixture of $CuCl_2$ and $CuCl_2{\cdot}2H_2O$ has a mass of 1.565 g. After suffiencient heating to drive off all the water, the mass is only 1.391 g. What is the mass percent of $CuCl_2{\cdot}2H_2O$ in the mixture?* **[4]**

(**Gegee: / *Given:*** M_{H2O} = 18.02 g.mol^{-1}; M_{CuCl2} = 134.45 g.mol^{-1}; $M_{CuCl2.2H2O}$ = 170.49 g.mol^{-1})

m_{H2O} = 1.565 g – 1.391 g = 0.174 g H_2O ✓

n_{H2O} = 0.174 g / 18.02 g.mol-1 = 0.00966 mol (9.66 x 10^{-3} mol) ✓

From the formula the ratio between $CuCl_2$ and H_2O in $CuCl_2{\cdot}2H_2O$ is: 1 $CuCl_2$: 2 H_2O

Therefor: 0.00966 mol of water equates to (0.00966 / 2 = 0.00483 mol) $CuCl_2{\cdot}2H_2O$

$m_{CuCl2.2H2O}$ = 0.00483 mol x 170.49 g.mol^{-1} = 0.823 g $CuCl_2{\cdot}2H_2O$ ✓

% $CuCl_2{\cdot}2H_2O$ in mixture = (0.823 g / 1.565 g) x 100 = 52.59 % ✓

Laat vir 'n klein speling toe op die antwoord, a.g.v. verskillende maniere van afronding.

VRAAG 9. / *QUESTION 9.*

Seewater is tipies 3.5% seesout en het 'n digtheid van 1.03 g.mL^{-1}. Hoeveel gram seesout sal benodig word om genoeg seewateroplossing voor te berei om 'n 62.5 L akwarium volledig vol te maak? / *Seawater is typically 3.5% sea salt and has a density of 1.03 g.mL^{-1}. How many grams of sea salt would be needed to prepare enough seawater solution to completely fill a 62.5 L aquarium?* **[3]**

3.5% sea salt = 3.5 g sea salt to 100 g solution.

Mass of the 62.5 L solution:

d = m/V; m = d x V = 1.03 g.mL^{-1} x 62.5 L x 1000 = 64375 g solution. ✓

Of this solution only 3.5% is sea salt.

Therefore: 64375 g x 0.035 = 2253.13 g sea salt. ✓✓

VRAAG 10. / *QUESTION 10.*

Definieer die term spesifieke hittekapasiteit. / *Define the term specific heat capacity.* **[2]**

Energy transfer as heat that is required to raise the temperature of 1 gram of a substance by one kelvin. ✓✓

VRAAG 11. / *QUESTION 11.*

'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/K.g). / *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/K.g).* **[4]**

Because of conservation of energy,

$q_{(Cr)} = -q_{(H2O)}$ (energy out of Cr = energy into H_2O) ✓

or $q_{(Cr)} + q_{(H2O)} = 0$

$q_{(Cr)} = (15.5\ g)(C_p)(18.9\ ^\circ C - 100.0\ ^\circ C)$

$q_{(Cr)} = -1257.05\ X\ C_p$ ✓

$q_{(H2O)} = (55.5\ g)(4.184\ J/K\bullet g)(18.9\ ^\circ C - 16.5\ ^\circ C)$

$q_{(H2O)} = 557.3088\ J$ ✓

$q_{(Cr)} + q_{(H2O)} = -1257.05\ C_p + 557.309 = 0 \rightarrow C_p = 0.443\ J/g\bullet K$ ✓

Laat vir 'n klein speling toe op die antwoord, a.g.v. verskillende maniere van afronding.

VRAAG 12. / *QUESTION 12.*

Noem drie dinge waarvan die hittekapasiteit van 'n voorwerp/element afhanklik is. / *Name three things that the heat capacity of a substance/element are dependend of.* **[3]**

The quantity of material. ✓

The magnitude of the temperature change. ✓

The identity of the material gaining or losing energy. ✓

PERIODIC TABLE OF THE ELEMENTS
PERIODIEKE INDELING VAN DIE ELEMENTE

IA (1)												IIIA (13)	IVA (14)	VA (15)	VIA (16)	VIIA (17)	0 (18)
1 **H** 1,01	IIA (2)																2 **He** 4,00
3 **Li** 6,94	4 **Be** 9,01											13 **Al** 27,0	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	IIIB (3)	IVB (4)	VB (5)	VIB (6)	VIIB (7)	VIII (8)	VIII (9)	VIII (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)									

atomic number / atoomgetal
symbol / simbool
atomic mass / atoommassa

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)

GUIDELINES TO PREDICT THE SOLUBILITY OF IONIC COMPOUNDS

SOLUBLE COMPOUNDS	
Almost all salts of Na^+, K^+, NH_4^+ **Salts of:** nitrate, NO_3^- chlorate, ClO_3^- perchlorate, ClO_4^- acetate, $CH_3CO_2^-$	**EXCEPTIONS**
Almost all salts of Cl^-, Br^-, I^-	Halides of Ag^+, Hg_2^{2+}, Pb^{2+}
Salts containing F^-	Fluorides of Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}
Salts of sulfate, SO_4^{2-}	Sulfates of Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}, Ag^+

INSOLUBLE COMPOUNDS	
	EXCEPTIONS
Most salts of: Carbonate, CO_3^{2-} Phosphate, PO_4^{3-} Oxalate, $C_2O_4^{2-}$ Chromate, CrO_4^{2-} Sulfide, S^{2-}	Salts of NH_4^+ and the alkali metal cations
Most metal hydroxides and oxides	Alkali metal hydroxides and $Ba(OH)_2$ and $Sr(OH)_2$